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February 13, 1930

Engineering News-Record

Devoted to Civil Engineering and Contracting

Rope-Strand Cables for Bridge at Portland, Ore.

Florida Rock Proves Satisfactory for Concrete

Four Steel Dams—Their Design and History

Overhead Trusses Carry Arch Centering

Dam Design Provides for Deflection

Stress Formulas for Semi-Elliptical Sewers

Viaduct Repaired by Welding and Guniting

Centering for Schuylkill River Bridge Supported by Overhead Trusses

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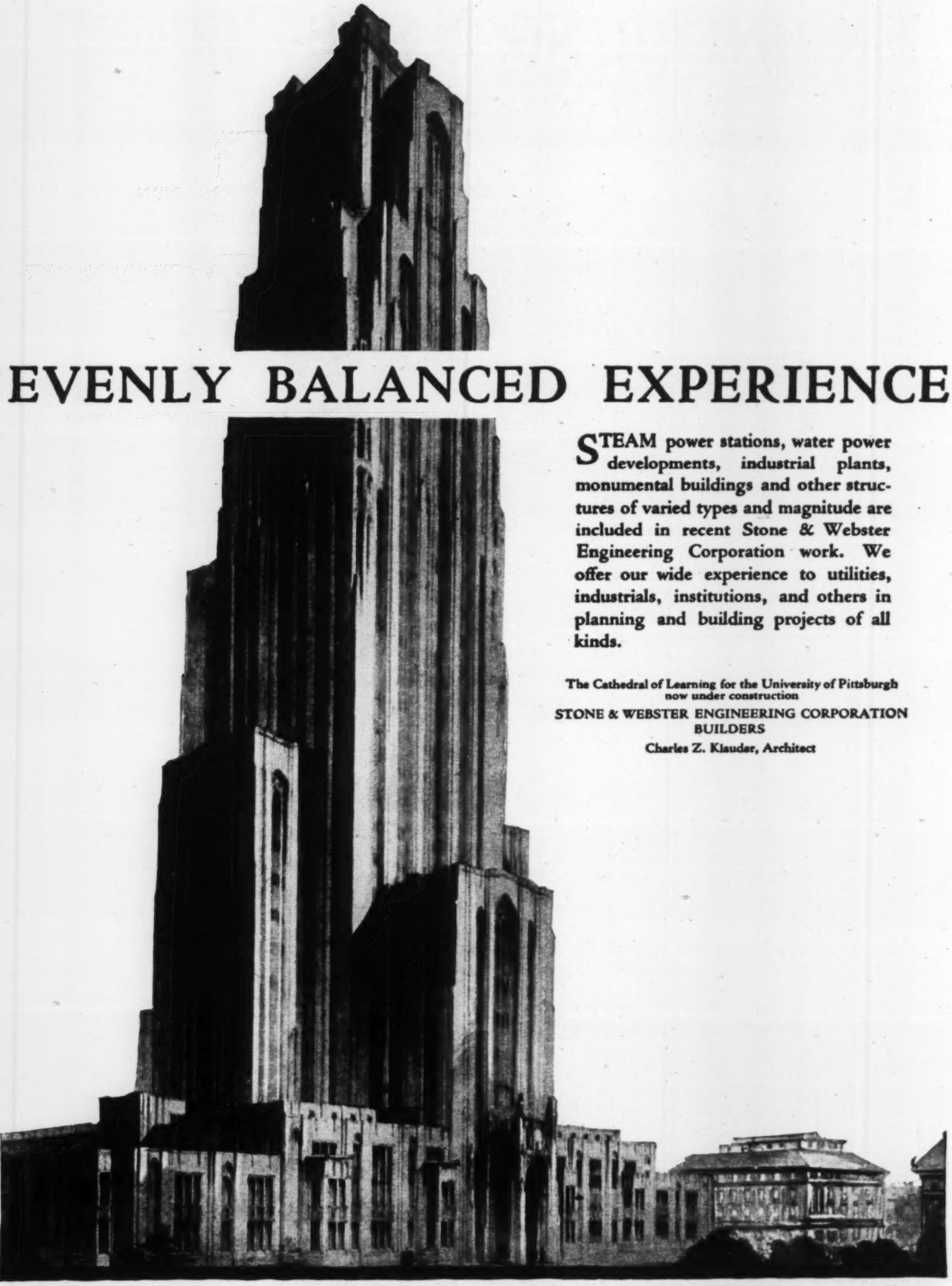

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ENGINEERING NEWS-RECORD

A McGRAW-HILL PUBLICATION — ESTABLISHED 1874

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 104 NEW YORK, FEBRUARY 13, 1930 Number 7

Unmasked

For years it has been suspected that the water-works official or operator entertains about the same high regard for consulting engineers as for manufacturers' representatives. True, he never has called the former a "peddler," except perhaps in upstairs conferences, but an attitude did shine through nevertheless. Now, finally, the Rocky Mountain Section of the American Water Works Association has revealed the inwardness of the situation in announcing its Feb. 13-14 meeting, by plainly putting the two classes of friends of the water-works industry on the same footing. "To help defray the cost of the convention," it says in its announcement, "a nominal registration fee of one dollar will be charged all non-members, and three dollars to manufacturers' representatives and consulting engineers." Thus the consultant is unmasked at last!

To Modernize an Old Machine

Write your Congressman and Senator asking him to support the public health service bill, H. R. 8807 and S. 3167; it aims to bring about highly necessary modernization of antiquated federal machinery which is related to the well-being of all through its activities in eliminating menaces to public health. One of the steps of reform is to place sanitary engineers in the service upon a footing of independence and efficiency. Engineering has wrought marvels for the community in the field of public health. It has done so despite the handicaps of bad organization and the minor and relatively uncertain status of the sanitary engineers in the service. Repeated attempts to remove these handicaps have failed, the last one two years ago by a presidential veto after both houses of Congress had approved the reform. Meantime national growth continues to bring forth each year more serious problems in sanitary control, and each year therefore an efficient system of national safeguarding of sanitary hazards becomes more important. The present bill should pass, and every engineer who supports it by writing to his Congressional representatives will strengthen the chance of the reform.

Real Port Development

A PROPOSAL to construct 1,000-ft. piers on both the New Jersey side of the Hudson River at New York and in Brooklyn, for the accommodation of large ships, as made by the Port of New York Authority, is the most important move made by the body since its organization. The proposal itself is of great importance in the development of the port. It also is important as indicating the Port Authority's confidence in its own ability to depart in a major way from the line of action laid down for it in the "comprehensive plan" for the development of the port which was written into the law creating the Port Authority. Moreover, this proposal taken in conjunction with the Port Authority's recent proposal to finance the construction of adequate rail connections to Jamaica Bay indicates that the port commissioners believe themselves so soundly established financially as to be able to undertake real port development work on a large scale. This journal has in the past protested against the tendency to convert the Port Authority into a bridge-building body, to the detriment of its primary function of developing the port. An effort is now being made to add interstate vehicular tunnel construction to the Port Authority's bridge building activities despite the fact that the states of New York and New Jersey have commissions for that purpose. The reverse would be the more reasonable move, the turning of the bridge work over to the Bridge and Tunnel commissions as soon as it can be done without detriment to the work. The Port Authority has real port work to do. It should no longer be burdened with these outside operations.

For Public Safety

Transcending in importance all structural revisions which are proposed for the new building code of New York City are those new provisions which would place responsibility for a structure on the designing architect or engineer. The old New York code has long been a model for building codes everywhere, so that all of the proposed revisions for the new code are of nation-wide interest. But these general clauses, referring to design responsibility, are doubly important since they are basic, and hold so much promise of alleviating bad design and construction, which is not wholly confined to New York City. The provisions written by the subcommittee on structural steel and iron—and substantially the same are suggested by the subcommittees on foundations and reinforced concrete—are as follows: (1) "All structural plans shall be accompanied by an affidavit of the designing engineer stating that he is familiar with the building code and that, to the best of his knowledge and belief, the design conforms with it." (2) "Before a certificate of occupancy is granted, an affidavit of the designing engineer shall be filed, stating that he has reviewed the shop drawings of the steel or other structural features, that these are in accordance with the plans and with the code requirements, and that the structure has been completed in accordance therewith." Engineers have long sought to bring about such fixing of responsibility as these provisions offer, and they should lose no time in embracing and supporting them. Other cities, now in the midst of code revision or contemplating it, would do well to watch New York City developments closely. The authorities in New York and the public generally should welcome the added assurance of safety and economy which these provisions offer. In the near future, the complete code will be drafted ready for acceptance.

Let everyone be certain of two things before the code is signed, namely, that these provisions are firmly in the code, safe from the whims and fancies of politics, and that the provisions are so worded that there can be no doubt of their legality and enforceability. City building work will lose an unparalleled opportunity for advancement if they fail or are rendered ineffective.

Safe Construction and Safe Maintenance

THAT safety has a money value far exceeding its cost is coming to be appreciated more and more thoroughly, and with this recognition comes increased attention to the requirements of safe design and construction. The struggle to promote safe construction has been long and slow; it will continue to be a struggle, but one which has increasingly favorable outlook as the resistance of inertia decreases. Because so much emphasis has been placed upon the necessity of assuring safety through the original design and construction, the importance of attention to safety in operation and maintenance is often in danger of being undervalued. Accidents constantly pile up evidence proving that no construction is permanently safe, and that lack of attention to maintained safety may be as evil as unsafe construction. Not long ago a film fire in a hospital led to the death of scores of persons because, aside from improper design and construction, the operating methods were shockingly bad. A well-built bridge in Colorado was the scene of a bad train wreck some months ago because stream conditions near-by had changed in such a way that the current produced by high floods washed out the embankment. Daily experience multiplies such illustrations. The lesson which they teach is that both original construction and maintenance play a part in safety; that all efforts toward establishing safe standards of design—in buildings, in roads and railways or elsewhere—are valuable and effective, but that unless supplemented by endeavors to maintain day-by-day safety, they may nevertheless fail. Yesterday's safety work, however effective, does not guarantee against today's accident.

Another Advance

COMPLETION of a 950-ft. span suspension bridge with rope-strand cables at Grand'Mere, Quebec, and the beginning of work on a similar structure with 1,207-ft. span at Portland, Oregon, described in this issue, signalize a development that has long been considered an ideal by many engineers. Cables built of assembled ropes were common in the early days of suspension bridges, but their shortcomings, chiefly their large and variable stretch and the resultant difficulty of good load-distribution, were so grave that it remained for the parallel-wire construction of cables to bring long-span bridges into being. The difficulty and slowness of the process of stringing cables wire by wire, aside from other factors, have always made the assembled-rope construction an attractive possibility, but manufacturers were not able to make rope or strand accurate in length, free from permanent stretch, and high in modulus. Production of strands of high modulus—up to 24,000,000 lb. per sq.in.—and pre-stretched in long lengths at high stress to give them their set, has now been accomplished, and thereby strand-construction of cables made possible in large bridges. The ability to guarantee a twisted wire rope to within ½ in. of specified length under any tension up to 65,000 lb., as was the case for the 1,700-ft. 1¼-in. diameter ropes at Grand'Mere and for the 2,700-ft. 1½-in. diameter ropes which make up the cables of the Portland bridge, is a distinct triumph for the wire manufacturer. Also, it provides another flexibility in suspension bridge construction, with several potential advantages. Field work can be simplified. The footwalks can be entirely dispensed with. Speed in construction can be augmented, since the strands can be manufactured before the towers and anchorages are completed. Strand adjustment can be freed from much of its intricacy. The rope-strand cable is one of the important byproducts of the present activity in suspension-bridge construction. A direct result of research which the manufacturer carried out in his studies of footwalk rope for the Fort Lee-Hudson River bridge, it represents an important advance in the suspension-bridge field.

Professional Selfishness

EFFORTS are being made in several states to convert laws intended for the protection of the public into instruments for the protection of a profession or craft. Such a movement has been active in Colorado; another, less marked but still definite, in New Jersey. In New York State a similar movement has temporarily succeeded in attaining its end. What has happened in the latter state is typical of the dangers at issue.

New York State has a license law for engineers and a registration law for architects. Both are predicated on the right of the state to prevent unsafe construction by forbidding untrained men to pass themselves off as trained engineers or architects. Both laws already have been successful in this respect in the limited time they have been on the statute books.

But this normal functioning of the law was not sufficient for a number of architects. They saw in their registration law a chance to squeeze out of the building field those engineers who for years have specialized in building construction and reconstruction—men of competence, men of whom it cannot be said that their practice endangers life or property. If these men could be kept from acting as principals for owners in building construction or reconstruction work by denying them the right to file plans with city building departments their practice would fall to architects.

When this idea was first conceived, the architects' law was not quite broad enough in its definition of the practice of architecture to insure the success of the movement, but, as the Regents of the University of the State of New York (the state department charged with the administration of professional laws) desired certain changes in the administrative sections of the law, it was easy to bring about the inclusion of a new definition of the practice of architecture. Accordingly the law was recently revised; the definition as it now stands is so broad that a sharp lawyer might attempt to prove even the building of a railroad tunnel under the Hudson River to constitute practicing architecture!

The new law went into effect on January 1, 1930. At once the architectural societies brought the modified provision of the law to the attention of the heads of building departments, pointing to the fact that the law makes it a misdemeanor for any person other than a registered architect to "design plans and specifications for structures or alterations exceeding $10,000 in cost." The building department heads in turn appealed to the assistant commissioner for higher education, who referred the matter to the state attorney general. The latter replied that until such time as the Regents formulate rules and regulations regarding the interpretation of the new architects' law in its relation to the engineers' license law, the building department heads should abide by the evident intent of the architects' law. Consequently no engineer is permitted to file plans in most of the building departments in the state.

To anyone familiar with the practice of architecture and engineering it is obvious that the two sciences overlap widely in the construction of modern buildings. Between the artistry of form and shape and the arrangement of masses to get proper effects—the architect's province—and the design of the structural frame of a great skyscraper—the province of the engineer—lies a broad territory in which both may work to good effect. But if public safety is the object, if a legislative body desires to fix responsibility for the safe construction of buildings upon either the architect or the engineer, reason dictates that the engineer be chosen, for all his training in the structural field has to do with strength of materials and the design of structures to be safe and stable.

In much and perhaps most building construction, no doubt architects occupy the position which they have occupied for generations past, that of principal agent for the owner in co-ordinating the various services which go into the construction. But modern developments have created many structures in which the technical functions are exclusively those of the engineer—such structures as our subways, for instance. These same developments have brought us buildings in which there is no vestige of architectural function, where of necessity all is engineering; and a still larger number in which engineering is dominant, where the architect is but a decorator who drapes the essential structure to suit ephemeral fancy. With this complex aggregate of modern building, is there place for a professional selfishness that would seek improper advantage through monopoly privilege?

For the time being the matter rests with the Regents of the University of the State of New York. It is within their power to say that the clause in the architects' registration law which says that the law shall not be considered as restricting the practice of engineering by a licensed professional engineer means that engineers may design and file plans without violating the architects' law, just as architects may now file plans without violating the engineers' law. Thus they may frankly recognize that the two professions overlap. Or the Regents may attempt to put all building construction in two groups, one the exclusive field of architects and the other of engineers. Architects are said to favor this latter course, because it would protect their practice in a wide field of building construction and eliminate engineers from any but secondary work. As a first step in that direction they have succeeded in getting the engineers' board of examiners to agree to a classification in which industrial buildings, that is, buildings devoted to manufacturing, power development and storage, or docks, are considered the province of the engineer and all other building work the province of the architect.

The whole movement is a regrettable display of professional jealousy, especially as it is fostered not by a small group of unscrupulous architects but by at least one of the architectural societies. It is more than this in its possible effects, however. It tends to lower the two professions to the status of two labor unions squabbling in a jurisdictional dispute. The architects appear not to have realized that enough prodding will stir the engineers into discarding the interprofessional courtesy which they have heretofore observed by demanding that architects cease to violate the engineers' license law—which most arctitects do—under the same strict interpretation of that law that architects want placed on theirs.

It is contemplated by the New York law that architectural malpractice shall not again bring about a Knickerbocker Theater horror. As an outgrowth of the present conflict engineers may find proper occasion to demand that engineering by architects be effectively curbed. The engineers do not seek dispute, but they cannot be expected to remain patient long in the face of the attack which the architectural profession has undertaken.

Growing Recognition of City Engineers

A SMALL room or two, poorly lighted, cluttered with odds and ends of surveying instruments, chance samples of sewer pipe and paving materials, old catalogs and a few nondescript books; floor bare and perhaps dirty; ceiling smoked; walls decorated by faded maps and photographs; such was the office of most city engineers until within the past decade or two, and such it still is in many small and medium-sized cities. Privacy was often lacking. Provision for the comfort and convenience of the information-seeking public needing access to records was usually overlooked.

Among many reasons for these conditions were the minor place accorded the city engineer in the municipal organization, city halls ill-suited for office use, and overcrowding through the growth of cities and of municipal functions. Recent years have shown marked changes in all these respects in progressive cities, large and small. Recently built city halls provide liberal space for engineering offices. The engineering department quarters in the new city hall at Columbus, Ohio, which we described in a recent issue, are commodious for a city of 300,000 and well laid out for the convenience of the chief engineer, his staff and visitors who have business there.

These marked changes in the quarters being provided for city engineers are in keeping with the growth of the work of the city engineer in volume and variety. They reflect, too, recognition of the position the city engineer now holds among other city officials. All this raises the city engineer and his staff in public esteem and gives added weight to his opinions on the amount of money needed for public improvements and how it should be expended.

The engineer today is one of the main elements in the efficient functioning of municipal government. Upon his knowledge and judgment depend the comfort, convenience and health of all the inhabitants of the city. To him is intrusted the major part of the city expenditures, outside of those for education. Marked as has been the growth in recognition of these facts, they are not appreciated in all cities. The engineering profession has not done its full part in bringing these truths home to the attention of mayors, councilmen, laymen, heads of administrative departments and, last but not least in importance, the citizenship generally. Here is an opportunity for local, state and national engineering societies that should be continuously kept in mind and made the basis for action.

Rope-Strand Cables Used in New Bridge at Portland, Oregon

St. Johns Bridge, With a 1,207-Ft. Suspended Span Over Willamette River, Sets New Record for Rope-Strand Cables—Extensive Architectural Studies Result in Use of Unique Batter-Leg Towers in Which Pointed Arches Accentuate the Pleasing Appearance

By D. B. Steinman

Robinson & Steinman, Consulting Engineers, New York City

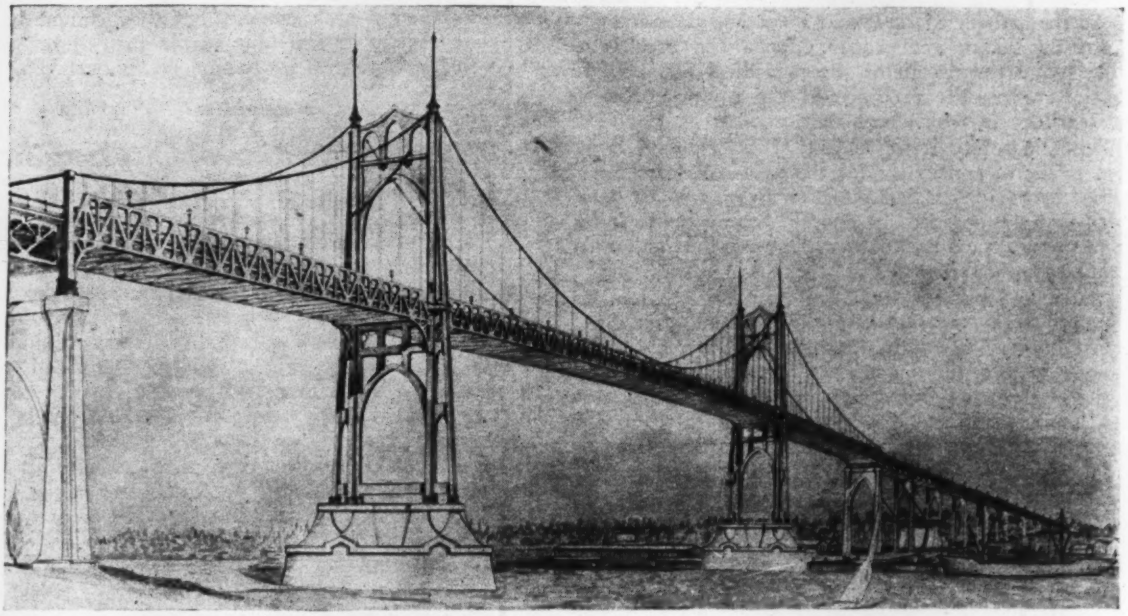


FIG. 1—NEW ST. JOHNS BRIDGE AT PORTLAND, ORE., AN ARTIST'S CONCEPTION
Longest span structure utilizing rope-strand cables. Notable also for architectural design featuring substitution of batter-legs for diagonal bracing in the main towers.

NOTABLE innovations in suspension bridge practice have been incorporated in the design of the St. Johns bridge, now under construction over the Willamette River at Portland, Ore. With a main suspended span of 1,207 ft., it represents the longest bridge upon which rope-strand cables have yet been used, and at the same time it is the longest suspension structure of any type west of Detroit. An underclearance of 205 ft. above navigable water constitutes an additional record. Unusually complete architectural studies accompanied its design. The use of batterleg towers, presenting a pleasing appearance by virtue of the elimination of the conventional diagonal bracing and the use of pointed arch outlines above and below the roadway are features worthy of note. This same motif of pointed arches is extended to the main masonry piers and to the approach piers, where the vaulted opening in the tallest of these piers exceeds a height of 150 ft. Duplication of truss span lengths in the approaches, combining the masonry of the anchorages with the masonry of the adjacent approach span piers, and the use of a special anchorage layout in which silicon steel plates form the anchor chains are other features of the structure.

The bridge is being built by Multnomah County to span the Willamette River between two sections of Portland—the St. Johns district on the east bank and the Linnton district on the west bank. Seven bridges now span the Willamette at Portland; the St. Johns bridge will be the most northerly crossing and nearest the point where the river flows into the Columbia River. The new bridge will afford a connection between the Upper Columbia River Highway east of Portland and the Lower Columbia River Highway from Portland to Astoria.

Alternative designs and estimates for cantilever and suspension designs, respectively, at four different locations were prepared. The comparative estimates revealed a saving of $640,000 by using a suspension design at the adopted location, a saving which would permit the capacity of the structure to be increased from three to four lanes. In addition a large balance of the authorized appropriation would be left unexpended. This suspension design was finally adopted and is now under construction.

In the St. Johns bridge, the desire to secure a beautiful public structure was a governing consideration. The selection of the suspension type, with its naturally graceful cable curves, was the first step in that direction. The development of the design of the high steel towers, to secure outlines in steel that would express the harmonious combination of beauty and strength, led to the adoption of pointed arches as the dominant motif, and this style of architecture also was carried out in the design of the tall reinforced-concrete piers of the viaduct approach.

Special designs for the ornamental balustrades, the

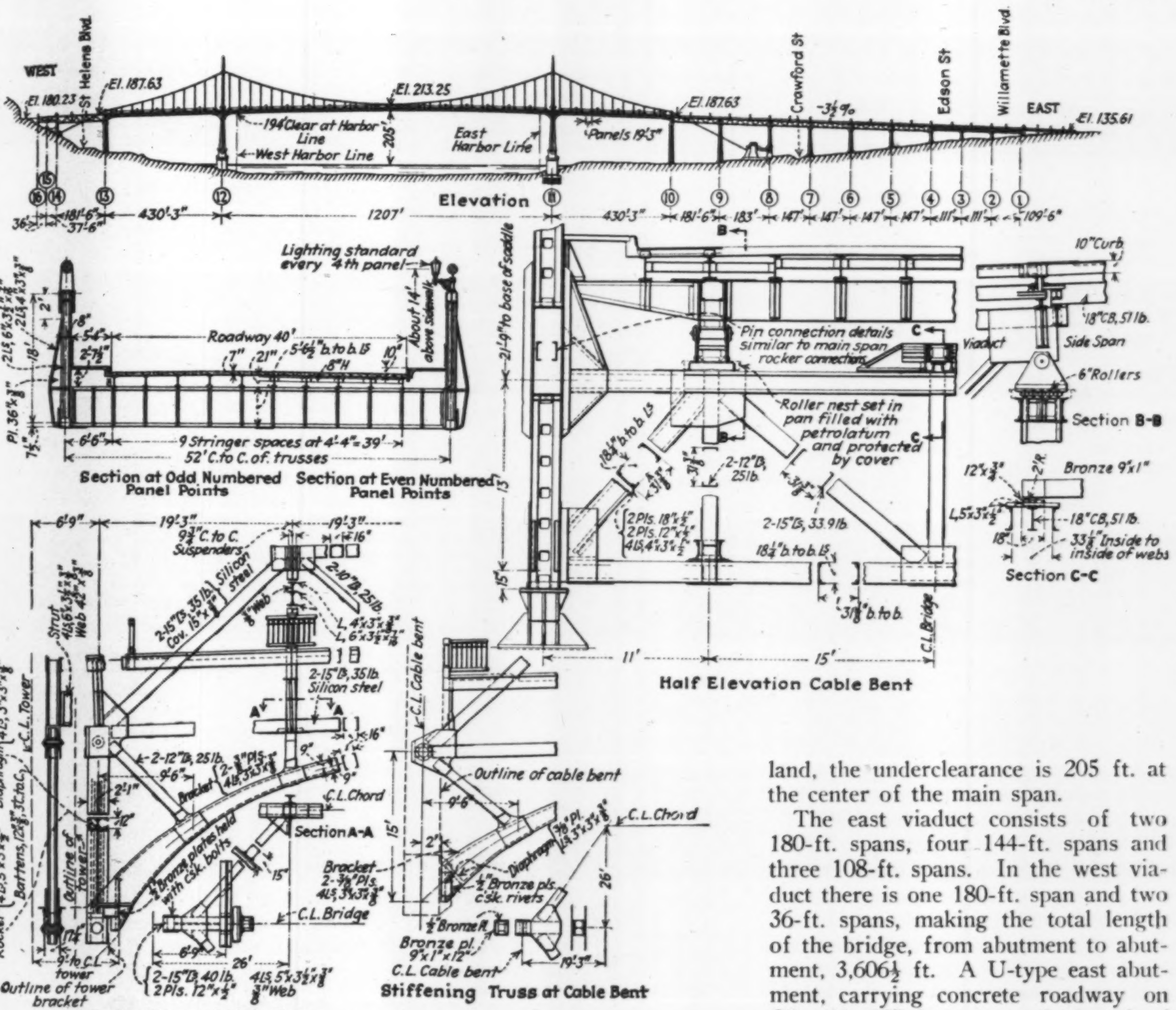

WEST
St. Helens Blvd.
El. 180.23
El. 187.63
El. 213.25
194' Clear at Harbor Line
West Harbor Line
205'
East Harbor Line
El. 187.63
Panels 19'3"
Crawford St
-3½%
Edson St
Willamette Blvd.
EAST
El. 135.61
Elevation
36'
181'6"
37'6"
430'3"
1207'
430'3"
181'6"
183'
147'
147'
147'
147'
111'
111'
109'6"
Lighting standard every 4th panel
Roadway 40'
About 14' above Sidewalk
9 Stringer spaces at 4'-4" = 39'
52' C. to C. of trusses
Section at Odd Numbered Panel Points
Section at Even Numbered Panel Points
21'-9" to base of saddle
Pin connection details similar to main span rocker connection
Roller nest set in pan filled with petrolatum and protected by cover
2-12"[, 25 lb.
2-15"[, 33.9 lb.
C.L. Bridge
11'
15'
Half Elevation Cable Bent
10" Curb
18" CB, 51 lb.
Viaduct
Side Span
6" Rollers
Section B-B
Bronze 9"x1"
18" CB, 51 lb.
33⅞" Inside to inside of webs
Section C-C
19'3"
19'3"
Silicon steel
2-15"[, 35 lb. Silicon steel
Section A-A
C.L. Chord
C.L. Bridge
C.L. Tower
Outline of tower
Rocker
Outline of tower bracket
26'
Stiffening Truss at Main Tower
C.L. Cable bent
Outline of cable bent
C.L. Chord
C.L. Cable bent
26'
19'3"
Stiffening Truss at Cable Bent

FIG. 2—PRINCIPAL DETAILS OF ST. JOHNS BRIDGE
Including stiffening truss connections at main and cable bent towers.

lighting standards and other details were developed to harmonize with the main towers. Details of the abutment pylons and parapets, the viaduct piers, the massive main piers and the anchorages were modeled to the graceful curves and contrasting reliefs of the governing style. A special attempt was made to develop each material in a manner appropriate to its accepted characteristics. It is sincerely hoped by the designers that the St. Johns bridge, by virtue of the substitution of buttressed columns and arched outlines for the conventional utilitarian X-bracing, of the gracefulness and rhythm of its approach spans supported on an arcade of concrete piers of ascending height, and of the harmonious development of the architectural features in an attempt to present a pleasing and impressive view of the structure from all possible angles, will establish a new mark in artistic bridge design.

Principal Dimensions—The main span of the St. Johns bridge clears the harbor lines with a length of 1,207 ft. center to center of main piers and is flanked by two suspended side spans each 430 ft. 3 in. long. The cable sag is 120.7 ft., one-tenth of the span. In order to meet navigation requirements established by the port of Portland, the underclearance is 205 ft. at the center of the main span.

The east viaduct consists of two 180-ft. spans, four 144-ft. spans and three 108-ft. spans. In the west viaduct there is one 180-ft. span and two 36-ft. spans, making the total length of the bridge, from abutment to abutment, 3,606½ ft. A U-type east abutment, carrying concrete roadway on fill, adds 227 ft. more to the length of the construction. The west abutment marks the junction with the west approach, which involves about 1 mile of side-hill road construction. Accordingly the work embraces about 4,000 ft. of bridge construction and 5,000 ft. of approach road construction.

Foundations—Preliminary wash borings, made at the four different locations contemplated for the proposed bridge, formed the basis for preliminary designs and comparative estimates. After the site was selected, final confirmatory core borings were made at the locations of the piers and anchorages. On the east bank the borings revealed only layers of clay and sand, which necessitated a substructure design with spread footings and with pile foundations under a number of piers. On the west bank the borings showed rock at El. —11 to —23 for the west main pier, and rock under 4 to 8 ft. of clay for the viaduct piers.

All piers are of reinforced concrete. The east main pier has its foundation at El. —50, on wood piles driven under water into hard sand. It contains 17,000 cu.yd. of reinforced concrete and in order to reduce its weight, 72-in. wood stave pipes are placed vertically in the body of the pier so as to leave hollow cylindrical shafts. The west main pier is founded on rock at El. —25.

The shafts of the viaduct piers are of tapering cruciform section, connected at the top with pointed arches. These piers ascend in height reaching El. +160 at pier No. 10. It is believed that this pier, 163 ft. from top to bottom and containing 3,700 cu.yd. of concrete and 150 tons of reinforcing steel, is the largest reinforced-concrete rigid-frame pier yet constructed. The piers are reinforced with structural steel frames supplemented with rod reinforcement.

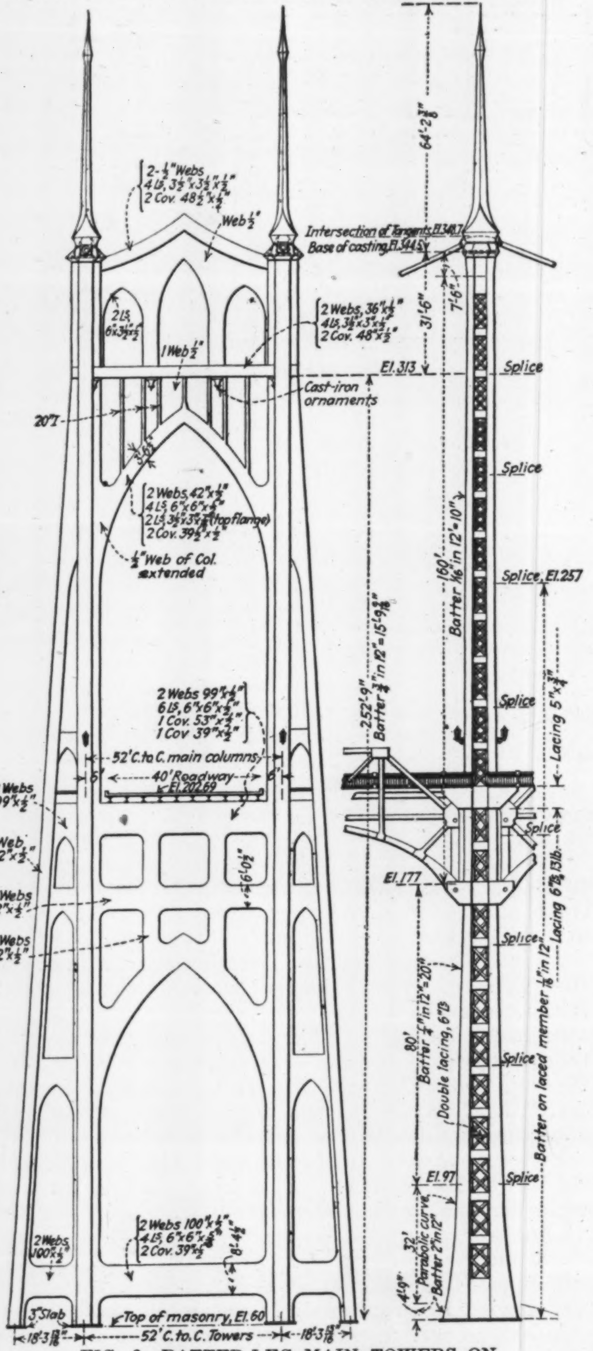

2-½" Webs
4 Ls 3½"x3½"x½"
2 Cov. 48½"x½"
Web ½"
Intersection of Tangents El. 348.7
Base of casting El. 344.5
2 Ls 6"x3½"x½"
1 Web ½"
2 Webs, 36"x½"
4 Ls 3½"x3"x½"
2 Cov. 48"x½"
64'-2⅞"
31'-6"
7'-6"
El. 313
Splice
Cast-iron ornaments
20'7"
2 Webs, 42"x½"
4 Ls 6"x6"x½"
2 Ls 3½"x3½"x½" (top flange)
2 Cov. 39½"x½"
½" Web of Col. extended
Splice
Splice, El. 257
160'
Batter 1/16" in 12"=10"
252'-9"
Batter ¾" in 12"=15'-9 11/16"
2 Webs 99"x½"
6 Ls 6"x6"x½"
1 Cov. 53"x½"
1 Cov 39"x½"
Splice
52' C. to C. main columns
40' Roadway
El. 202.69
Lacing 5"x⅜"
2 Webs 99"x½"
Web 72"x½"
2 Webs 72"x½"
2 Webs 52"x½"
16'-0½"
Splice
El. 177
Lacing 6" [13 lb.
Splice
80'
Batter ¼" in 12"=20"
Double lacing, 6" [
Splice
Batter on laced member 1/16" in 12"
El. 97
Splice
32'
Parabolic curve Batter 2" in 12"
41'-9"
2 Webs 100"x½"
4 Ls 6"x6"x⅝"
2 Cov. 39"x½"
8'-4⅞"
2 Webs 100"x½"
3' Slab
Top of masonry, El. 60
18'-3 13/16"
52' C. to C. Towers
18'-3 13/16"

FIG. 3—BATTER-LEG MAIN TOWERS ON ST. JOHNS BRIDGE

Vertical leg for direct loads and batter-legs in lieu of diagonal bracing, combined with pointed arch portal outlines, are distinguishing factors in architectural design of the bridge

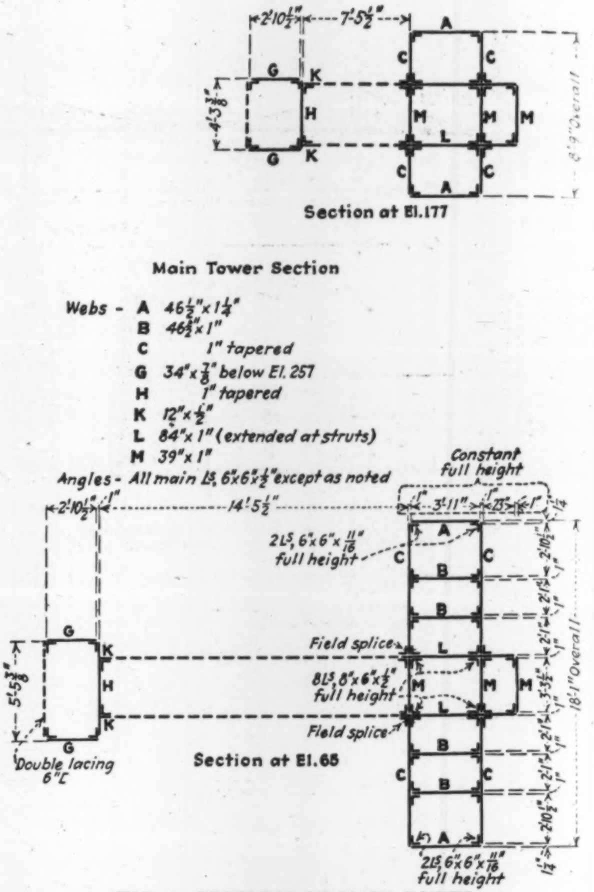

2'-10½"
7'-5½"
4'-3⅞"
8'-9" Overall
A
C
G
K
H
M
L
Section at El. 177
Main Tower Section
Webs - A 46½"x1¼"
B 46½"x1"
C 1" tapered
G 34"x⅞" below El. 257
H 1" tapered
K 12"x½"
L 84"x1" (extended at struts)
M 39"x1"
Angles - All main Ls 6"x6"x½" except as noted
Constant full height
2'-10½"
14'-5½"
3'-11"
2Ls 6"x6"x 11/16" full height
Field splice
8Ls 8"x6"x½" full height
Field splice
5'-5⅞"
Double lacing 6" [
Section at El. 65
2Ls 6"x6"x 11/16" full height
18'-1" Overall

FIG. 4—SECTIONS OF MAIN TOWER

The east anchorage is 115 ft. long, 91 ft. wide and extends from El. +12 to +82. It contains 13,000 cu.yd. of concrete. In addition there are hollow chambers filled with sand, to provide a total weight of 30,000 tons. A stepped foundation on a spread footing is used with pedestal concrete piles to provide additional horizontal and vertical resistance. About half of these piles are battered.

The west anchorage is in a tunnel cut from the solid rock. It is surmounted by an exterior structure supporting viaduct piers Nos. 14 and 15.

The anchorage steel is shown in Fig. 7. The anchor chains, connecting to the anchor girders, are formed of plates of silicon steel, with reinforcing pin-plates, as a substitute for the usual eyebar construction.

Main Towers and Cable Bents—The main towers, comprising one of the unusual features of the structure, are of medium-carbon steel, of the semi-flexible type, fixed at the base. Each tower consists of two main vertical columns, 52 ft. center to center, supplemented by outside batter-legs. The combination of vertical legs for direct load with batter-legs for bracing produces a highly satisfying solution of the esthetic problem of tower design for suspension bridges. The effectiveness of the pointed arches in the towers of the Mount Hope bridge, near Providence, R. I., prompted the adoption and further development of this motif in the design of the St. Johns bridge, where similar arches are utilized both above and below the roadway as shown in Figs. 1 and 3.

The tower legs are of cruciform section, with box divisions. The main column section tapers from a width of 18 ft. at the base to 7 ft. 4 in. under the saddles, with a constant breadth of 4 ft. 1 in. The total height of the towers, including the finials, is 408.7 ft. above mean low water.

Following the mathematical analysis of the deflections

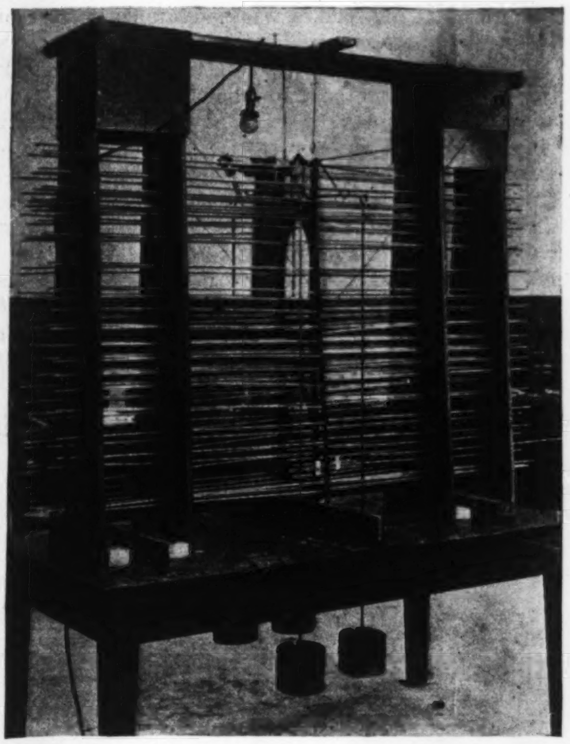


FIG. 5—MODEL ANALYSIS SET-UP FOR ST. JOHNS BRIDGE TOWERS
Note application of cable loads to top of celluloid tower model by weights hanging beneath table. Transverse loads applied simultaneously with vertical loads gave deflections that indicated stresses below computed values.

and stresses in the main towers, check tests were made on an elastic model (Fig. 5) built up of sheets of celluloid to represent the variations of cross-section and moments of inertia. Scale forces were applied to represent the simultaneous action of maximum vertical and transverse loads on the tower, precision strain gages being used to read the stresses. This work was done by the engineering staff for the bridge under the supervision of Prof. George E. Beggs, in the engineering laboratory at Princeton University.

The model test results were distinctly reassuring, being in all cases lower than the computed stresses and strains. The indicated maximum transverse deflection of the tower top, referred to the scale of the actual structure, was $2\frac{1}{8}$ in. from 30-lb. wind load combined with the effect of the resultant eccentricity of the maximum vertical reactions from cable and truss loads. The maximum indicated fiber stress, after adding the computed stress from unbalanced cable pull, was only 14,000 lb. per sq.in. The model tests showed that the tower was generously proportioned for any combination of loadings to which it might be subjected.

The cable bents are of the rocker type, but are provided with wing plates at the base to hold them during erection, these plates to be burned off after the cables are in place. The connection between the cable bent columns and the side span stiffening trusses is made by means of 6-in. pins in lubricated bronze bushings. A transverse truss in the cable bent supports the roller bearings for the 180 ft. approach span and the center-line sliding bearing for the lateral truss of the suspended side span.

Twisted Strand Cables—Following the successful application in 1928 of twisted strands for the cables of the 950-ft. span Grand'Mere bridge in Quebec (*Engineering News-Record,* Nov. 18, 1929, p. 841), the specifications for the St. Johns bridge invited bids on twisted-strand construction as an alternative to the parallel wire cable design. The two alternative bids of the John A. Roebling's Sons Company were lower than any other bids received for the cables and showed a saving of $42,000 by adopting the twisted-strand design. Moreover, the proposal announced an expected saving of two months in the time of completion of the bridge, this saving in time being made possible by dispensing with the con-

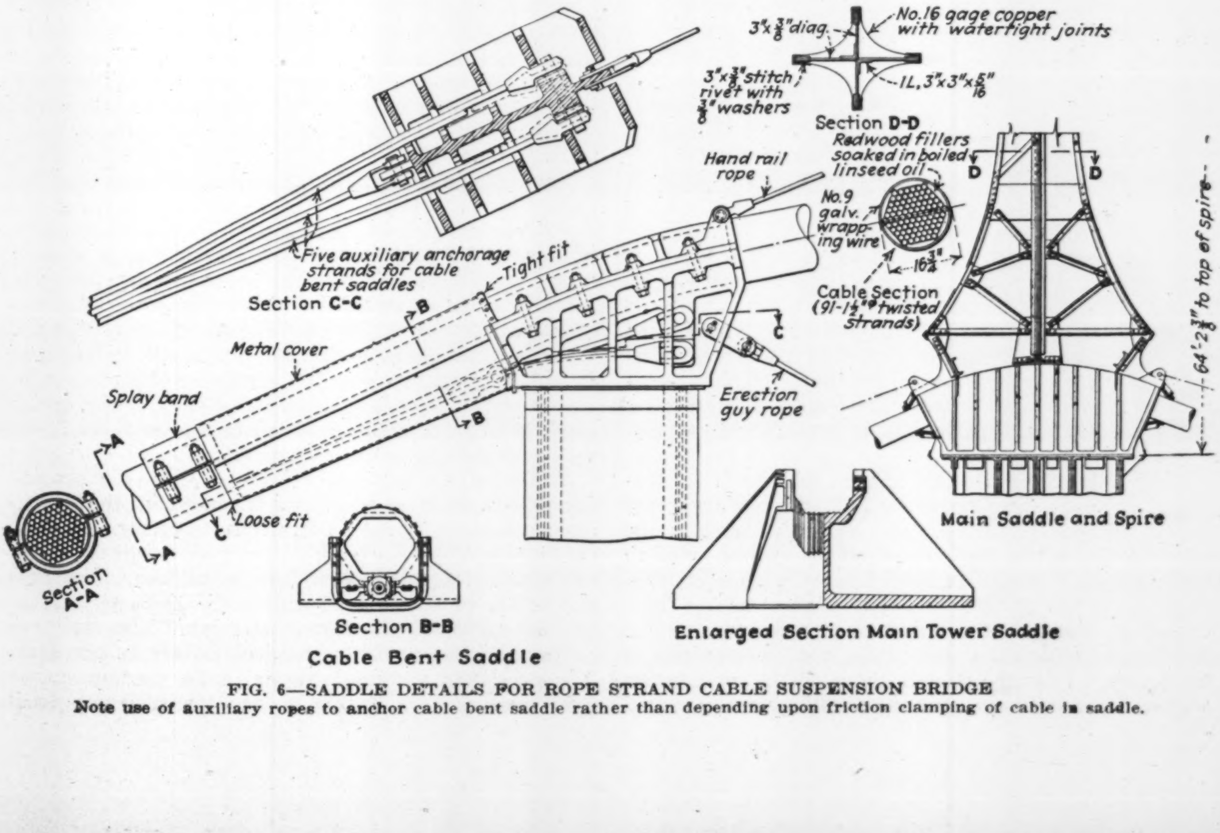
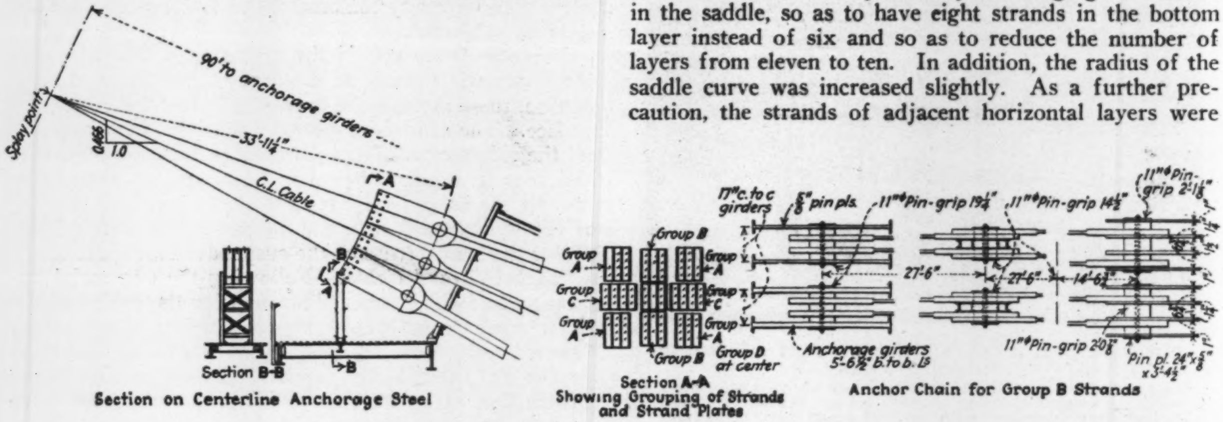

Five auxiliary anchorage strands for cable bent saddles
Section C-C
Tight fit
B
Metal cover
Splay band
A
C
Loose fit
B
C
Hand rail rope
Erection guy rope
Section A-A
Section B-B
Cable Bent Saddle
3"x 3/8" diag.
No.16 gage copper with watertight joints
3"x 3/8" stitch rivet with 3/8" washers
1L, 3"x3"x 5/16"
Section D-D
Redwood fillers soaked in boiled linseed oil
No.9 galv. wrapping wire
16 3/4"
Cable Section (91-1½" ϕ twisted strands)
D
D
64'-2 3/8" to top of spire
Main Saddle and Spire
Enlarged Section Main Tower Saddle

FIG. 6—SADDLE DETAILS FOR ROPE STRAND CABLE SUSPENSION BRIDGE
Note use of auxiliary ropes to anchor cable bent saddle rather than depending upon friction clamping of cable in saddle.

struction of footbridges and by shortening the time required for cable stringing.

Under the specifications the successful bidder on the twisted-strand construction absorbs the cost of the slight strengthening of towers and anchorages to carry the increased cable weight and also assumes any extra cost of modification of details of saddles and anchorage connections. In the St. Johns bridge the required strengthening of the main sections of the towers and anchor chains amounted to less than 2 per cent.

The parallel wire design provided for each cable to consist of nineteen strands of 184 No. 6 galvanized wires each, yielding a sectional area of 105.47 sq.in. The specified physical properties were 170,000 lb. yield point, 225,000 lb. ultimate strength and 27,000,000 lb. modulus of elasticity. The cable diameter was specified as 12¾ in., but the use of twisted-strand construction increased this to 16¾ in. before wrapping. An incidental advantage accruing from the increase in cable size was an improved appearance of the bridge as a whole. In each cable as adopted, there are 91 twisted strands of 1½-in. diam., yielding a metallic sectional area of 121.64 sq.in. The specification requires the twisted-strand design to match the parallel-wire design in guaranteed total ultimate strength, total yield point and total resistance to elongation. These requirements are more than met by the adopted design, which guarantees an ultimate strength per strand of 135 tons, a yield point of 75 per cent of the ultimate strength and a guaranteed modulus of elasticity of 22,000,000. Actual tests have shown a breaking strength per strand of 150 tons and a modulus of 25,000,000.



Section on Centerline Anchorage Steel

Section A-A Showing Grouping of Strands and Strand Plates

Anchor Chain for Group B Strands

FIG. 7—ANCHORAGE STEEL FOR ROPE-STRAND CABLES
Silicon steel plate chains are used in place of conventional eyebars.

The 91 strands form a hexagonal cable which after coating with red lead paste is to be filled out to a cylindrical section by the addition of segmental fillers of redwood soaked in boiled linseed oil. The outside wrapping will consist of No. 9 galvanized wire and three coats of paint.

Main Cable Saddles—One of the problems in twisted-strand cable construction is the limitation of maximum lateral pressure on the strands, as for instance in the cable saddles where the bottom strands are subjected to concentrated vertical pressure from the superimposed strands. It was at first proposed to place a 30x4½-in. curved steel slab horizontally across each main saddle, dividing the cable and thus relieving the lower strands of the pressure from the strands above. This construction was not ideal, however, since the resulting vertical spread of the cables at the saddles was undesirable because of adjustment and stress considerations.

To aid in a solution of the problem, tests were made at the Trenton plant of the John A. Roebling's Sons Company to determine the effect of transverse pressure on the physical properties of the strands under tension. Previously published tests have shown that cable wires are unaffected in strength and yield point by pressures of 3,300 lb. per linear inch of wire. The tests performed for the St. Johns bridge showed that even higher pressures did not affect the physical properties of twisted strands, although they did produce visible deformation of section of the wires in the outer layers. It was decided to limit the maximum pressures to 3,300 lb. per linear inch. This was accomplished by rearranging the strands in the saddle, so as to have eight strands in the bottom layer instead of six and so as to reduce the number of layers from eleven to ten. In addition, the radius of the saddle curve was increased slightly. As a further precaution, the strands of adjacent horizontal layers were designed to have opposite lay, so as to obtain "valley" contact rather than "crossing" contact between the contiguous wires.

As shown in Fig. 5, the cable bent saddle is a departure from usual design in that anchorage for each saddle is provided by five auxiliary ropes instead of by friction clamping of the cable strands in the saddle.

Strand Assembly—The strand assembly detail (Fig. 7) for the anchorage of the strands is similar to that developed for the Grand'Mere bridge, except for the increase in scale from 37 to 91 strands. Three tiers of three groups of parallel vertical plates receive the strands. The groups in the bottom and top tiers anchor ten strands each. The middle group of the middle tier anchors seven strands, and the outside groups anchor twelve strands each. The groups of plates are inclined to face the splay point of the cable, and each group is connected to its anchor chain by an 11-in. pin, except the center group, where a 10-in. pin is used. The plates vary in thickness from 1 to 1½ in. according to the number of strands held. The strand sockets bear against cast-steel blocks, which are held in place between the plates by two long 2¼-in. steel rods going through each group.

Stiffening Trusses and Viaduct Spans—To provide for a 40-ft. roadway and two 5-ft. sidewalks, the stiffening trusses are spaced 52 ft. center to center. A truss depth of one sixty-seventh of the main span, or 18 ft., and a panel length of 19 ft. 3 in. are utilized. The truss chords are of silicon steel with a 45,000 lb. yield point and an 80/95,000 lb. ultimate strength. They are proportioned for a working stress of 32,000 lb. per sq.in. The maximum working stresses in the medium-carbon steel members are 26,000 lb. for the stiffening truss diagonals and 18,000 lb. for the hangers, floor system and bracing.

Only two different sections, two 15-in. channels of 35 and 40 lb. respectively, are used for the upper chord, the heavier section being required only from the one-sixth to the five-twelfths point of the main span. The lower chord sections also are two 15-in. channels, of 35, 40, 45, and 50 lb. weights respectively.

The truss splices are laid out for fabrication and erection of the trusses in two-panel units, 38½ ft. long. Expansion movement for the main and side spans is provided by supporting the spans on rocker posts at the main towers, as shown in Fig. 2, and these rocker posts are covered by the end brackets extending under two truss panels each side of each tower. The connections at the top and bottom of the rocker posts consist of 6-in. pins in bronze bushings, provided with grease-cup lubrication.

The layout of the approach viaducts was planned for maximum duplication of span and panel lengths, together with special consideration to esthetic requirements. It provides duplication of 180-ft., 144-ft. and 108-ft. spans, with truss depths of 18 ft. for the two former span lengths and 9 ft. for the 108-ft. spans. All panel lengths are 9 ft. These viaduct trusses are deck type, 30 ft. center, the roadway and sidewalks being cantilevered out to obtain the total required width of 50 ft.

Contract Costs and Quantities—The work is divided into seven contracts, which were awarded to the respective lowest bidders as follows:

(1) Substructure: Gilpin Construction Company, Portland	$1,026,897.00
(2) Fabrication and Erection of Bridge Steel: Wallace Bridge & Structural Steel Co., Seattle	986,445.80
(3) Furnishing and Erection of Cables: John A. Roebling's Sons Company, Trenton, N. J.	472,200.00
(4) West Approach: La Pointe Construction Company, Portland	267,603.40
(5) Fabrication and Erection of Viaduct Steel: U. S. Steel Products Company, San Francisco	290,000.00
(6) Concrete Deck: Lindstrom & Feigenson, Portland	146,060.00
(7) Electrical Work: National Electric Company, Portland	33,000.00

The total contract cost was $3,222,206.20, which was $572,000 below the estimate of the engineers. The authorized bond issue for the bridge was $4,250,000, so that allowing for cost of right-of-way, engineering and contingencies, it is estimated that more than half a million dollars of the appropriation will remain unexpended.

Personnel—The St. Johns bridge was designed by Robinson & Steinman, consulting engineers, New York City, and is being constructed under their direction, with R. Boblow as resident engineer. The work is being done under the authority of the board of county commissioners of Multnomah County, consisting of Clay S. Morse, chairman, Grant Phegley and Fred W. German. The highway department of the county is represented by George W. Buck, county roadmaster and M. E. Reed, county bridge engineer.

Reinforced-Concrete Columns With Cast-Iron Cores

Reduced Size for Given Strength Is Advantage in Large Buildings—Solid and Hollow Cores—Use and Tests

VARIOUS inquiries received as to the nature and service of the Emperger type of reinforced-concrete column, used in a number of buildings, including the McGraw-Hill Building, Chicago (*Engineering News-Record,* July 25, 1929, p. 129), are answered by the following compilation of authoritative data.

In this type of reinforced-concrete column, as generally used, the center is a solid cast-iron bar or core, while near the exterior is a steel spiral attached to vertical bars. The spiral represents about 1 to 2 per cent of the cross-sectional area of column, the vertical bars about 1 to 4 per cent and the cast-iron core from 5 to 30 per cent in different designs. The main advantage claimed over ordinary reinforced-concrete columns is a material reduction in size, due to the substitution of one cast-iron member for several steel members. In tall buildings this reduction in size amounts to 8 or 10 in. in diameter of column, with the same or even less cost per linear foot, besides enabling more stories to be built than with ordinary reinforced-concrete without reaching excessive column sizes. The advantage in reducing the size of column is not so much the saving in floor space but rather: (1) the saving of space in congested service areas, as between elevators and around stairways, and (2) architectural value or appearance of the smaller column. A method for the design of columns with cast-iron cores was given in *Engineering News-Record,* March 4, 1920, p. 459.

It has been suggested that a structural-steel core, as sometimes used, would give greater strength. But tests to destruction are reported to have shown the contrary, and in tests made by the Austrian Concrete Committee, the cast-iron cores embedded in hooped concrete carried twice as much as structural steel in similar concrete. Further, the cast-iron core has a lower price and can be obtained usually in less time than structural steel of heavy section. The castings are made purposely with a rough surface to effect good bond with the concrete. In Chicago, however, the ruling or special ordinance under which the Emperger columns are built does not give the concrete any credit when structural steel cores are used.

Some inquiries assumed the cast-iron-core columns to be cast-iron columns fireproofed with concrete, and asked how the reinforced-concrete beams are connected to the cast-iron. In their design the columns are treated as reinforced-concrete columns, to which the concrete beams are connected in the usual way, as was shown in the description of the McGraw-Hill Building. There is no attachment of the horizontal reinforcement to the cast-iron core.

In designing the McGraw-Hill Building, the columns were made of uniform section (24 and 26 in. square) from basement to roof for economy, convenience and rapidity in construction. Since the cost of formwork in tall buildings amounts to about 40 per cent of the entire cost of the structural frame or skeleton, a decided saving in forms was accomplished. The variation in carrying capacity was obtained by reducing the cast-iron cores gradually from 12¾ to 3 in. in diameter. For the upper floors, where cores were not needed, standard hooped concrete construction was used. It was estimated by the designer that with the ordinary type of steel reinforcement the McGraw-Hill Building column section required would have been 34 and 36 in. square. In the 30-story Trustees Building, now under construction in Chicago, the Emperger columns are 30 in. square in the basement and 28 in. from the first story upward, with 2¾- to 2½-in. cores.

Building Code Provision—Since the use of cast-iron cores is not covered by the old building code of Chicago (which is now being studied for revision), the design of these columns in the Chicago buildings was governed by a special ruling of the city building department which arbitrarily assigns the stresses as follows: on cast-iron core, 9,200 lb. per sq.in.; on vertical steel bars, 13,200 lb.; on concrete, with its 1 per cent of steel spiral, 800 lb. In the revised code this type of column may be dealt with more fully.

Test Results—Tests made at Lewis Institute, Chicago, in 1919 included three types of columns and two of each type: (1) ordinary reinforced-concrete with 1 per cent spiral reinforcement of No. 12 wire at ½-in. pitch, and eight ¼-in. rods; (2) similar construction, but without vertical rods and having a solid 2-in. round steel core, 8.15 per cent of sectional area; (3) identical with the second except that the core was of cast iron. All the columns were 6 ft. long and 7 in. in diameter at the steel spiral, the exterior being octagonal, 7½ in. across the sides. A 1 : 1 : 2 concrete was used. The results given in Table I are the averages for the two columns of each kind.

Tests of the bond between the cast-iron cores and the concrete were also made at Lewis Institute in 1919, under the direction of Prof. D. A. Abrams, with results as shown in Table II. These cores are normally cast with rough surfaces for the purpose of bonding, as noted already, but in the bond tests the cores were smooth. The test pieces were octagonal, 7 in. in diameter inside the spiral hooping, with the 2-in. smooth cast-iron cores projecting ½ in. from the top. All were made of 1 : 1 : 2 concrete and had 1 per cent of vertical bar reinforcement.

TABLE I—TESTS OF CONCRETE COLUMNS HAVING DIFFERENT KINDS OF REINFORCEMENT

	With Ordinary Reinforcement, Lb.	With Steel Core, Lb.	With Cast-Iron Core, Lb.
Total load	193,000	354,150	345,500
Total per sq.in.	5,010	9,190	8,975
Total on hooped concrete	177,300	177,300	177,300
Total on metal core	......	176,850	168,200
Load on metal core per sq.in.	......	56,300	53,500

TABLE II—TESTS OF BOND OF CAST-IRON CORES IN CONCRETE COLUMNS

	Length		Length	
	12 In.	24 In.	12 In.	24 In.
Spiral reinforcing, per cent	1	2	1	2
Area of bond surface, sq.in.	76.5	156	76.5	156
Average ultimate load, total	70,000	137,400	89,500	160,200
Average ultimate load per sq.in.	915	883	1,170	1,030

TABLE III—COLUMNS WITH HOLLOW CAST-IRON CORES

Column Length, Ft.	No. of Vertical Bars	Ave. Max. Load, Lb.	Load on Concrete, Lb.	Load on Cast-Iron Total, Lb.	Load on Cast-Iron Per Sq.In., Lb.
6	6	1,041,500	405,000	636,500	51,400
10	6	943,375	405,000	536,375	43,400
18	2	930,250	405,000	525,250	42,400
20	2	858,000	405,000	453,000	36,650

TABLE IV—COLUMNS WITH BUILT-UP CORES OF STEEL AND CAST-IRON ANGLES

	Cols. With Ordinary Reinforcement		Cols. With Steel Angles	Cols. With Cast-Iron Angles		
	Min.	Max.	A	B	C	D
Length, in.	59.00	59.00	59.00	90.5	90.5	90.5
Diameter of spiral, in.	11.63	11.85	12.00	11.03	11.03	12.00
Ratio length to diameter	5.07	5.07	4.92	8.20	8.20	7.54
Area of column inside spiral, sq.in.	106	110	113.5	95.5	75.5	113.5
Vertical bars (4), area, sq.in.	1.245	1.245	1.245	None	1.245	1.245
Vert. bars; per cent of col. area	1.18	1.13	1.10	None	1.30	1.10
Ult. load, total	326,500	596,000	816,000	640,000	707,000	1,544,000
Ult. load per sq.in.	3,080	5,420	7,190	6,700	7,400	13,600
Ult. load on hooped concrete and bars	......	......	373,000	201,000	233,000	518,000
Ult. load on metal core, lb.	......	......	443,000	439,000	474,000	1,026,000
Ult. load on metal core, per sq.in.	......	......	47,300	91,800	99,100	103,500

A—Core area, 9.37 sq.in.; 8.25 per cent. *B* and *C*—Core area, 4.78 sq.in.; 5 per cent. *D*—Core area, 9.93 sq.in. 8.75 per cent.

Hollow cast-iron cores were proposed originally and have been used to a limited extent in this country. They are made with enlarged ends for socketed joints, but the solid cores are considered to be sounder castings, while their smaller diameter avoids interference with the horizontal reinforcing at connections of columns to beams and girders. Tests on hollow-cored columns were made by the U. S. Bureau of Standards in 1917, at the suggestion of L. J. Mensch, consulting engineer, Chicago, on columns 6 to 14 ft. long, 12¾ in. in diameter or 12 in. inside the steel spiral. The cast-iron core was 6 in. in outside diameter, with wall ¾ in. thick. It was not filled with concrete. A summary of the results of these tests is given in Table III. (See also *Engineering News-Record*, Sept. 11, 1919, p. 521.)

Tests with columns having built-up cores of steel and cast-iron angles were made by the Austrian Concrete Committee in 1926, with results as shown in the accompanying table. In each case there were four angles tied by flat bars at 10-in. intervals and forming a box column. The steel angles were 3.14x3.14x0.39 in., and those of cast iron were of approximately the same size. These tests (Table IV) were for experiment only, as the cost of such columns would be considerably higher than for unit cores of structural steel or cast iron. In each case the hooped concrete was reinforced by four vertical bars.

Buildings having the Emperger type of column, in addition to those already mentioned, include the following: Surf Hotel, Chicago, eleven stories; two sixteen-story apartment buildings at 3730-40 Sheridan Road, Chicago; Aragon Hotel, Chicago, twelve stories; Krolick Department Store, Detroit, 150x250 ft., twelve stories, with column loads of 2,000,000 lb., and a building of the same size for the Detroit Pressed Steel Company. Of these, the Surf Hotel and the Krolick store have hollow cast-iron cores.

Core-Drill Cuts 32-In. Hole

How large well holes were driven in rock to depths of 50 ft. a few years ago is described in the *Illinois Engineer,* the bulletin of the Illinois Society of Engineers, from which the following particulars are condensed. For installing two hydraulic freight elevators in a building at Nashville, Tenn., perfectly plumb wells were required for the 21-in. cylinders, 50 ft. long. These wells, 22 in. in diameter, were cut with a special core drill and core lifter, using the crushed steel process and advancing about 1 ft. per hour. For a 32-in. well 50 ft. deep, at Aurora, Ill., a similar rig was used, but with a 30-in. pipe 10 ft. long as the barrel, driven at 20 r.p.m. On the top of this barrel was a cast-iron cone with a central hole threaded for an 8-in. pipe which served as the drill rod. On the bottom of the barrel were riveted four cutting shoes of forged wrought iron. At Nashville, in solid limestone, the drill could be run down nearly the full length of the core barrel before pulling the core, the core lengths ranging from 2 to 6 ft. At Aurora there were many seams in the rock and the longest cores were only about 3 ft. long.

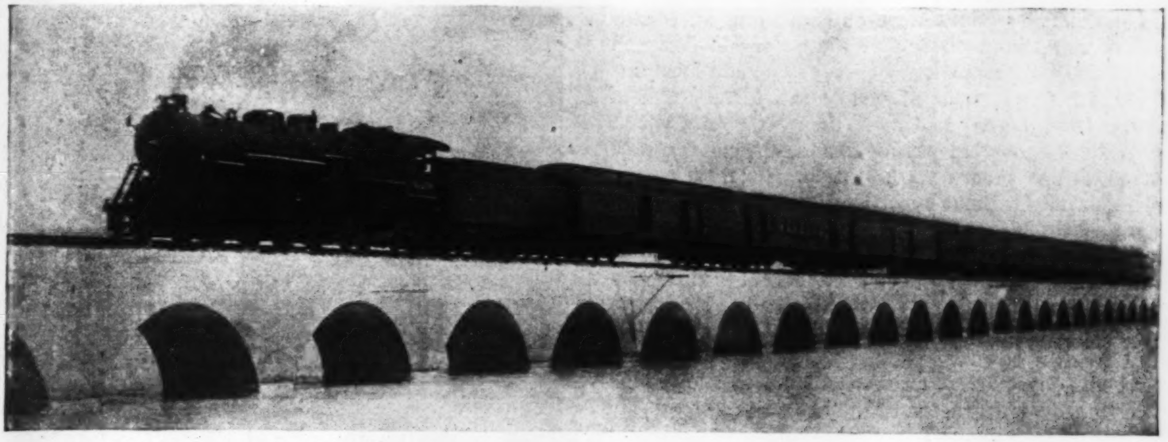


FIG. 1—FLORIDA EAST COAST RAILWAY OVERSEAS VIADUCT TO KEY WEST
Built twenty years ago of mass concrete, using local materials as aggregates.

Florida Rock Proves Satisfactory for Concrete

Crushing to 1-In. Maximum Size Eliminates Weak Marl-Filled Pockets—Durability Shown by Twenty-Year-Old Overseas Railroad Bridge—Approved for Federal-Aid Highway

By H. R. Albion
District Engineer, Portland Cement Association, Jacksonville, Fla.

CONCRETE construction in Florida, especially in the southern part, has long been handicapped by the belief that the soft native rock was unsuited as an aggregate, requiring expensive importation of this commodity from other states. In seeking a relief from this economic disadvantage, Florida rock has been used experimentally in the past few years in constructing concrete roads, buildings and seawalls, and the success of these ventures, coupled with isolated cases of older construction using this material in concrete showing remarkable durability, has disproved the old belief and establishes Florida rock as a permissible concrete aggregate.

Geologically Florida is of very recent origin, accounting for the nature of its rock. Gravel is found in a limited area only in the northwest section, along the Georgia and Alabama borders. Elsewhere relatively soft limestone offers the only material for concrete, except for small, local deposits of harder, so-called flint rock in the softer formation. And, compared with the harder stone ordinarily found in other states and used as normal concrete aggregate, this stone is soft. Because of long-standing and standard requirements as to hardness in concrete aggregate, Florida stone could not qualify.

Most specifications in the United States require a coarse aggregate showing not over 7 per cent of wear in the standard wear test. In considering the reason for this specification it became evident that concrete paving would be the only concrete which might be subjected to abrasion such as would involve a consideration of the hardness of the aggregate. With steel-shod vehicles almost non-existent and tire chains unknown in Florida, this requirement lost its force. In some locations the somewhat higher porosity of the soft rock would be objectionable because of frost action, but this, of course, is of no consequence in Florida.

Old Concrete Structures Using Florida Rock—In Fort Myers, on Second St., a stretch of concrete paving twenty years old in which Florida rock was used as coarse aggregate is still smooth and in fine condition (Fig. 4).

Possibly the best-known concrete structure in Florida is the overseas extension of the Florida East Coast Railroad to Key West, shown in Fig. 1, and the massive boat slips at the Key West terminal. Local material dredged near the site of the work was used in building many miles of viaduct on this line. These structures are in first-class condition after twenty years of use, and it is impossible to forecast their length of life.

The many beautiful concrete buildings in St. Augustine, though some of them are 43 years old, show no signs of distintegration. Wonderful in architecture and costly in undertaking, all the large hotels and churches of America's oldest city are built of monolithic concrete, with small coquina shells and fine sand used as aggregates (Fig. 3).

A twenty-year-old seawall at Tampa, built of Hernando County rock, is still sound and in good condition.

More Recent Construction—These older examples of concrete construction demonstrated that local rock could be used successfully and that what was really needed was a sound technique or construction standard, based on Florida conditions. An excellent example of the newer construction is found at St. Petersburg. In 1926 a waterfront improvement program called for the building of a large amount of concrete seawall and a municipally owned recreation pier located well out in Old Tampa Bay, reached by a wide viaduct carrying car tracks, driveways and sidewalks. Local rock was used in these structures.

In 1925 B. M. Duncan, then city engineer of Miami and now state highway engineer, built a stretch of experimental paving in Miami on North Miami Ave. About a dozen individual sections were built utilizing all combinatons of mix, from pit run of the quarry to designed mixes of definite proportions of local stone and local fine sand. These test sections proved so satisfactory that in 1927 and 1928 the city laid more than 300,000 sq.yd. of 8-in., 3,000-lb. concrete paving that cost an average of about $1.60 per square yard. Incidentally, this paving was laid entirely without expansion joints and has shown no signs of cracking (Fig. 2).

Probably Mr. Duncan's greatest contribution to the use of Florida rock is discovery relating to aggregate size. The rock in the Miami territory has a popcorn appearance containing holes filled with sand or marl, or both. Using the ordinary sizes of coarse aggregate, from ½ to 2½ in., tests of compression cylinders showed no satisfactory or uniform results. The larger aggregate pieces seemed responsible for this, for the cylinders always broke through them and through the marl-filled cavities. Mr. Duncan found that crushing the stone to a smaller maximum size remedied the trouble. In crushing, the marl-filled pockets were broken up, and the rock structure was such that a 1-in. maximum size would yield a product free from weak spots and very uniform in quality. This formed the basis for a new specification, and use was made of it in the designed mix employed in all the paving.

At the same time rock producers in Hernando County, in the Tampa area on the west coast, were working along somewhat different lines but with the same object in view. They were operating big plants that produced considerable tonnage. Better preparation of a more uniform product appeared to be their greatest need, next to convincing Florida users that their stone was suitable generally for all concrete purposes. The local plants now market their products quite generally for all classes of construction, and they are accepted as wholly satisfactory under the specifications governing their use. Aggregate preparation is uniform and standardized to a large degree.

With the work of the various interested engineers and producers more or less unrelated and independent, co-ordination of effort seemed desirable and advisable, so an aggregate survey of the entire state was made and a series of tests followed. Such tests covered typical commercial production of both fine and coarse aggregates in Florida. The results confirm all that had been done and all that had been expected.

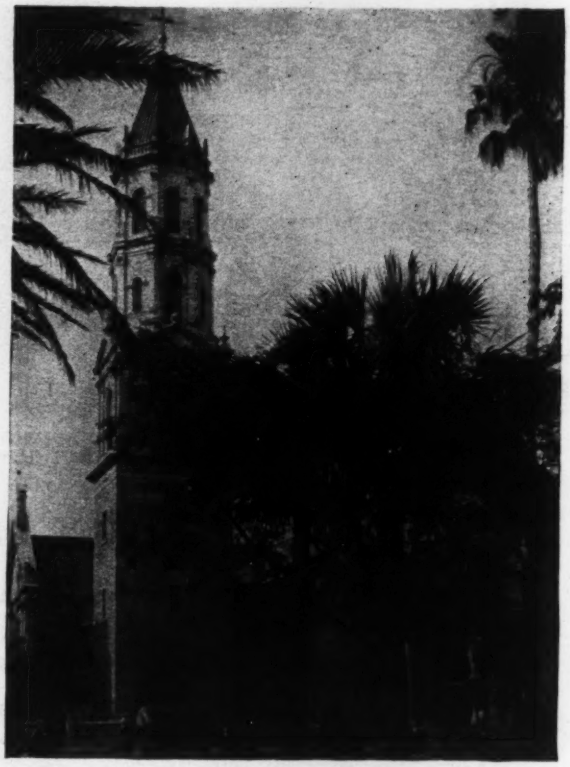


FIG. 3—CATHEDRAL ST. AUGUSTINE
Part of this structure is more than 100 years old. The spire was built of monolithic concrete in 1886, using local aggregates, consisting mostly of coquina shells and fine sand.

Many miles of excellent pavement have been built by the state and other agencies in which Hernando County stone was used as the coarse aggregate. Rock from the Miami area is now being used in the highway construction and this material will be used for the first time in a federal-aid project in the construction of State Highway No. 4, 9.21 miles long, between Del Ray and the Broward County line, a 10-8-10-in. slab 20 ft. wide, unreinforced and laid on sand subgrade.

It cannot be said that all recent construction using native rock has been successful, but in cases in which failure has occurred careful investigation has shown the trouble has been due to poor workmanship and not because of the aggregates used. Disintegration because of badly honeycombed concrete, or due to reinforcing rods having been carelessly placed too close to the forms, would have occurred regardless of the nature of the aggregates. Most convincing evidence of this is found in several structures, which, though built throughout of the same materials, are disintegrating in places while other parts of the same structure are wholly sound.

The Miami area is probably affected more than any other part of the state by the permissible use of local aggregate.

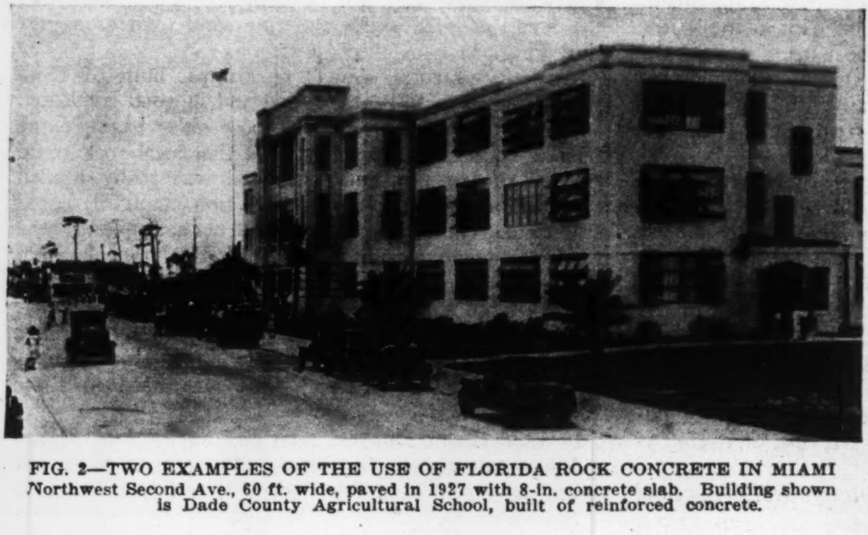


FIG. 2—TWO EXAMPLES OF THE USE OF FLORIDA ROCK CONCRETE IN MIAMI
Northwest Second Ave., 60 ft. wide, paved in 1927 with 8-in. concrete slab. Building shown is Dade County Agricultural School, built of reinforced concrete.

FIG. 4—EXCELLENT CONDITION OF CONCRETE PAVEMENT ON SECOND ST., FORT MYERS
Built in 1909, using local materials as aggregates.

Four years ago this community depended almost entirely upon aggregates brought in from far-away sources at relatively high prices. Today practically all construction utilizes aggregates produced locally and at extremely low cost. Reinforced-concrete building construction costs are remarkably low, and the effect of this is shown in the widespread use of this type of construction. In this section as well as in other portions of the state a tremendous economic saving has been effected by the use of native rock in concrete.

Four Steel Dams—Their Design and History

Two Now in Good Condition After Long Service—One Failed in Foundation—One Proposed in Germany

By J. F. Jackson
Consulting Engineer, Milwaukee, Wis.

Recent inquiry as to dams of structural steel construction has suggested the following notes as to the present situation and the advantages of dams of this type.

The Redridge steel dam, near the shore of Lake Superior, in Houghton County, Michigan, was built in 1900 for the Baltic Mining Company, now a part of the Copper Range Consolidated Mining Company, to provide a water supply for its stamp mill or concentrator, as described by me in *Engineering News* of Dec. 20, 1900, p. 421. I recently visited the structure and examined it quite carefully. I also have at hand a report on its condition which was made some weeks ago by Edward Koeppel, superintendent of the Copper Range Consolidated Company's mills, which is in agreement with my own opinions.

The dam is 480 ft. in length and 75 ft. in height at its center portion. It was built as a gravity structure, but some additional security was obtained by the use of long and heavy rods for anchoring the steel bents. Its main feature is the use of triangular steel bents spaced 8 ft. c. to c., and having the inclined members covered with a series of $\frac{3}{8}$-in. steel plates. These plates, concave to the water, are close riveted at the edges, beveled and calked as in a steel boiler. They were made much thicker than was necessary to sustain the water pressure, on the theory that some allowance should be made for possible rust. As a matter of fact, the plates seem to be in first-class condition on the water side. A light slime covers the steel. There is little or no circulation of the fresh water to bring entrained air to cause rust.

On the under side the curved plates are entirely dry at all times and are in perfect condition. The supporting bents are also almost entirely protected from the weather, because of their position under the plates. They are in perfect condition, except for a few small rust spots on a few column bases. This structure has been repainted only once, in 1913. The steelwork is and always has been as watertight as a bottle or a steel boiler. There have been a few small leaks of no consequence through the coarse concrete of the foundation and at one point the concrete shows a little spalling from moisture and frost. A hundred dollars or so would put everything, both steel and concrete, in perfect condition, and I understand that the mining company is now attending to the matter.

The first steel dam of this type was built for the Santa Fe Railway at Ash Fork, Ariz., as described in *Engineering News* in 1898. The Redridge dam was the second of this general type. A third was built in the Missouri River near Helena, Mont., but failed after about one year's service, the center part having been built on a defective foundation. Part of it, founded on solid rock, remained standing. Later it was replaced by a concrete dam. A dam of steel and iron is to be built near Minden, Germany, in connection with a hydro-electric plant, according to a recent note in *Engineering News-Record*.

In the light of subsequent development of this type of dam, let me say that the Redridge design is not particularly good or economical, though it will compare favorably with any concrete or masonry dam of standard design. Improvements can be made in new design of the same type. Here are some points of superiority obtained in this form of construction: (1) watertight as a boiler; (2) no fear of settlement or distortion cracks, since it is built of elastic material; (3) a general factor of safety of four or more as desired; (4) easy to obtain factor of safety against sliding at least twice that usually obtained in masonry or concrete construction; (5) no anxiety or uncertainty about hydrostatic uplift; (6) long life and easy inspection. These observations apply only to steel dams built on favorable sites. There are, of course, economical heights, maximum and minimum, depending on location of site and other factors. There should be a revival of interest in this type of construction.

The Ash Fork dam was described in *Engineering News* of May 12, 1898, p. 299; and the Houghton or Redridge dam, Dec. 20, 1900, p. 421, and Aug. 15, 1901, p. 107. A recent report from the Santa Fe Railway states that the Ash Fork dam is in good condition, and except for requiring periodical painting it is still rendering good service at low maintenance cost. Information as to the Helena or Hauser Lake dam, including both the steel and the concrete designs, was given in *Engineering News* as follows: Sept. 14, 1905, p. 255; Nov. 14, 1907, p. 507; April 30, 1908, p. 491; June 22 and Aug. 10, 1911, pp. 743 and 163. Discussions on modifications of these designs for structural steel dams will be found in *Engineering News* of 1903, as follows: June 11, p. 526; July 16, Aug. 6 and Sept. 3, pp. 13, 59, 123 and 206; also Sept. 28, 1905, p. 323. A combined structural steel and concrete design was given in the same paper of Nov. 16, 1899, pp. 315 and 320, and a steel-faced rockfill dam on Jan. 1, 1903, p. 2. Since the Helena dam there seems to have been little if anything said or published in reference to this very special type of dam until the recent brief announcement of a proposed steel dam at Minden, Germany, and the paper read by Mr. Goldmark before the American Institute of Steel Construction, as noted in *Engineering News-Record* of Aug. 1, and Nov. 21, 1929, pp. 191 and 811.—Editor.

Overhead Trusses Carry Arch Centering for Pennsylvania R.R. Bridge at Philadelphia

Forms for 173-Ft. Concrete Arch Spans Over Schuylkill River Suspended by Rods From Movable Truss System—Two Unusually Large Steel Pneumatic Caissons, One 163x58 Ft., Sunk for Foundations

By William H. Fowler
Secretary, Dravo Contracting Company, Pittsburgh, Pa.

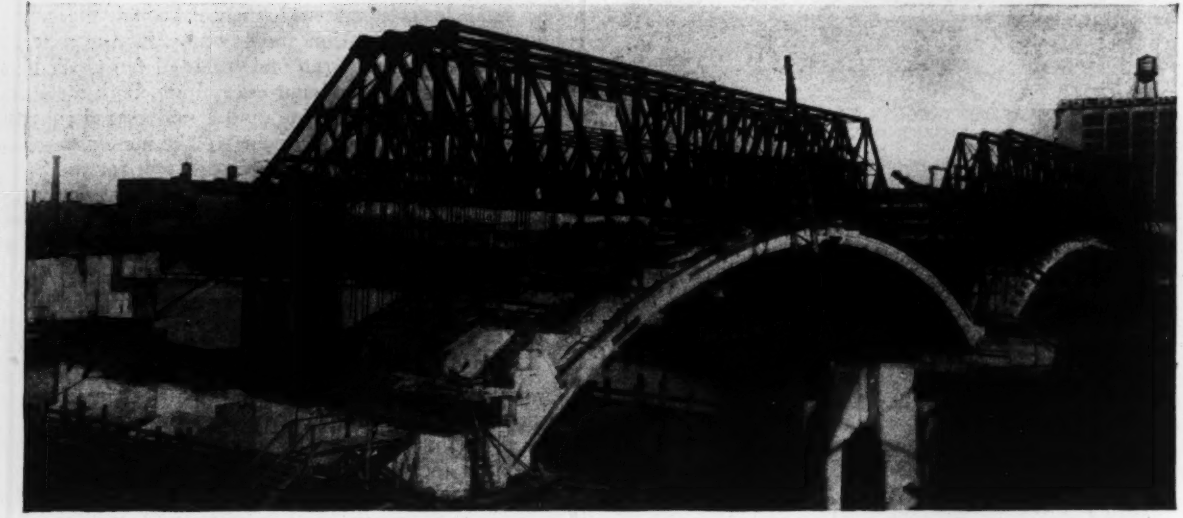


FIG. 1—OVERHEAD TRUSSES SUPPORTING ARCH CENTERING, SCHUYLKILL RIVER BRIDGE, PHILADELPHIA

THE USE of overhead trusses to carry the arch forms and the sinking of two of the largest steel pneumatic caissons ever built are construction features of the Pennsylvania Railroad's new concrete bridge being built over the Schuylkill River in Philadelphia. Crossing the river near the new West Philadelphia station, now under construction, the bridge forms a link in the road's Philadelphia improvement program. It will be used exclusively by electrified suburban service, which will enter the new station through a subway leading from the new bridge.

The structure consists of two five-centered concrete arches of 172-ft. $8\frac{7}{16}$-in. span and 31-ft. rise, each with heavily reinforced barrels 3 ft. thick at the crown and 6 ft. 3¼ in. thick at the springing line. The roadbed will be carried on an 18-in. reinforced-concrete deck slab supported on cross-walls 2 ft. thick, spaced about 10 ft. 5 in. on centers. The spandrel wells, of reinforced concrete faced with stone, are closed except for small ventilating panels along the top and have expansion joints above the springing lines. Stone facing is to be used on the entire structure above a plane of 2 ft. below mean low water, granite on the lower 8 ft. and Pennsylvania sandstone from Curwensville on the remainder.

In plan the bridge is a trapezoid, with its wide base, 132 ft., along the west abutment, from which point the tracks will converge toward the narrow base, 96 ft. wide, at the east abutment. Both arches are skewed, the south face about 1 deg. 47 min., and the north face about 4 deg.

The foundation consists of three pneumatic caissons, resting on rock from 28 to 38 ft. below mean low water. For the west abutment a steel floating caisson 163 ft. 3 in. x 58 ft. in plan and 25 ft. deep was built with twelve shafts 7 ft. in diameter. This is one of the largest steel pneumatic caissons ever sunk for bridge foundations. The caisson was fabricated at the contractor's plant in Pittsburgh, assembled and launched at its yards at Wilmington, Del., and towed to the bridge site. A similar steel caisson 166½x37 ft. was built for the center pier. A concrete caisson 123½x50 ft. and 21½ ft. high was built in place on a steel cutting edge within a cofferdam of steel sheet piling for the east abutment. The west abutment caisson was sunk in February and March, the center pier in April and the east abutment in May. Because of their unusual length, special care was required in sinking the caissons, but the work was accomplished without mishap. At the west abutment soft mud was found, and compact sand and gravel were encountered at the center pier and east abutment. The fastest progress made in sinking was on the east caisson, which went down 19 ft. in twenty days.

Supporting the arch centering presented an unusual problem. An unobstructed channel 75 ft. wide with a 27-ft. clearance above mean low water was required for navigation. The springing line of the arches is but 12½ ft. above water level. Specifications called for placing the barrel of each arch in four longitudinal sections of approximately equal size with longitudinal key blocks 4 ft. wide between adjacent ring sections. After considering various methods of supporting the centering, a suspended system using overhead trusses was adopted. No precedent has been found for this type of support, which was developed to meet conditions encountered at the site.

The trusses are carried on the pier and abutments on

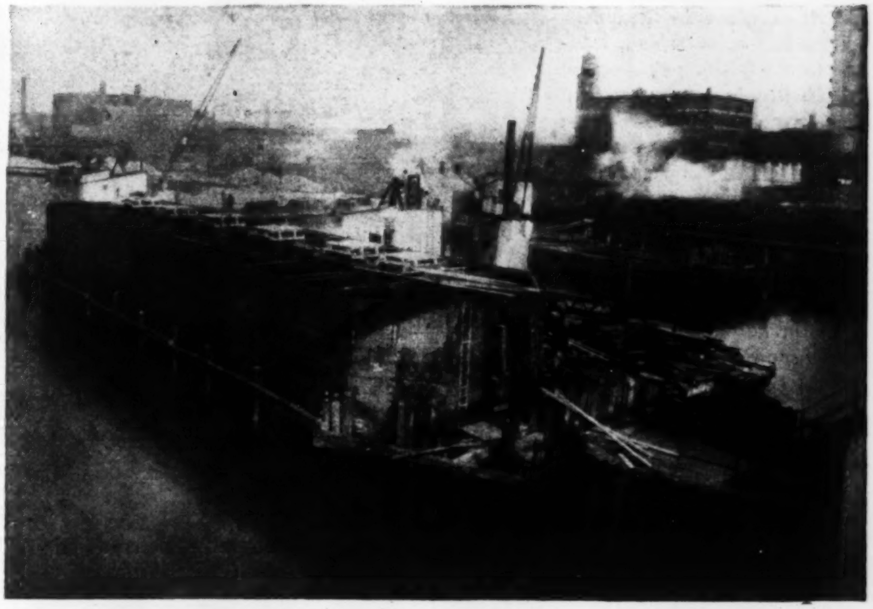


FIG. 3—CENTER PIER STEEL PNEUMATIC CAISSON, 166x37 FT., READY FOR SINKING

framed steel bents resting on I-beam grillages so designed that the trusses may be shifted from one section of the arch ring to the next. Each truss is made up of twenty panels of 8½ ft. each, and two end panels of 11½ ft. each, having a total span length of 193 ft. and a rise of 30 ft. They were erected on framed bents resting on piling adjacent to the bridge and were then slid onto the pier and abutments. Because of the varying width of ring sections, four trusses are required for the west span and three for the east span, the trusses being spaced 8 ft. on centers.

Adjustable tension rods 2 to 2¼ in. in diameter, arranged in pairs, support the centering, which consists of 6-in. wood lagging carried on pairs of 20.7- to 35-lb. 12-in. channels, curved to fit the required radius. The lagging for the centering of each span is divided into seven panels for convenience in removal.

Each of the panels is from 32 to 36 ft. wide and about 25 ft. long, consisting of the 6-in. lagging bolted to the curved channel ribs. The tension rods are carried on seats riveted to both sides of the webs of 12-in. steel beam vertical posts of the trusses. The centering provided is sufficient for one ring section of each arch and will be used four times.

Setting of the voussoir stones commenced as soon as the lagging was placed, the stones being carried from the skewback up both sides to and including the keystone. Alternate joints were left open, ½-in. lead pads being placed in the open joints to provide for settlement of the voussoirs uniformly with the arch ring during progressive deflection of the falsework. Reinforcing steel and bulkheads were placed while the stone setting was in progress, to permit concreting to begin as soon as the keystone was set.

Concreting each ring is completed in four pours, placed in the following order: (1) 38-ft. crown section; (2) two sections each 30 ft. long on either side of the crown section, leaving a 4½-ft. keyway between pours; (3) two remaining 24-ft. sections of the ring next to the skewbacks, leaving a 4½-ft. keyway on the upper side and a 5-ft. keyway next to the skewback. Batches are placed alternately on either side of the crown in order to preserve symmetrical loading. The last pour fills in the keyways.

The deflection of the falsework under the weight of the concrete was computed and the lagging set high enough so that the arch ring after pouring would reach the desired elevation. For this adjustment the hanger rods were threaded at the top and provided with nuts and lubricated bronze washers. To avoid excessive stresses in the hanger rods supporting the first pour, due to increments of truss deflection in the succeeding pours and under the consequent adjustments, rubber washers were provided 6 in. in diameter and 1 in. thick. The total deflection at the crown was about 3½ in.

After placing the concrete in the keys, a period of fourteen days is allowed for curing. The centering is then released by slacking off the tension rods and removing the bolts from the 12-in. channel rib splices and is lowered to barges by steam cranes. After the lagging panels are removed, the trusses are unbolted from the supporting grillages and slid along the well-lubricated top of the grillage. The motive power for sliding is

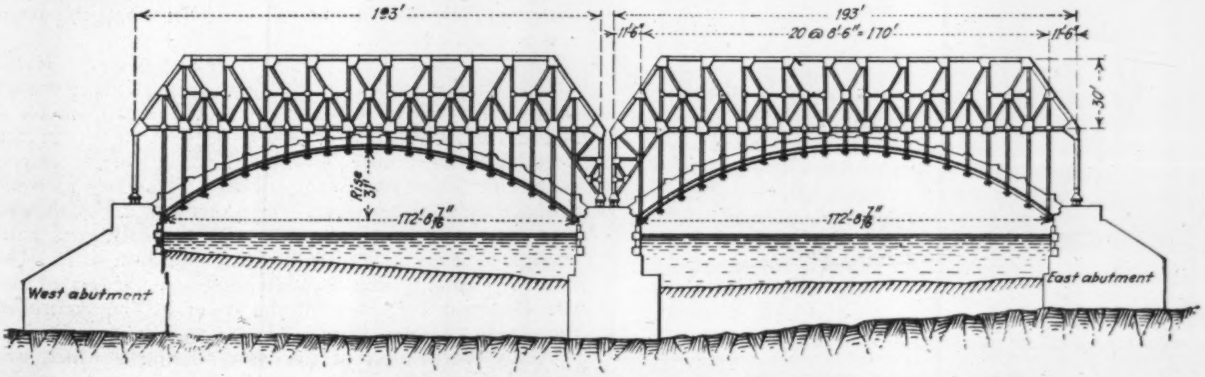


FIG. 2—DIAGRAM OF TRUSSES AND HANGER SYSTEM

provided by seven-part blocks and cables at each end, leading to the fall line of a crane, assisted by hydraulic jacks in breaking the shoes loose from the grillages at the start. After bolting the trusses in their new position to the grillages, the centering panels are raised to position one at a time by four derricks.

Rapid progress has been made on the bridge and it is expected to be completed about May 1, 1930. Robert Farnham, chief engineer, Philadelphia Improvements, is supervising the work for the Pennsylvania Railroad. The Dravo Contracting Company, Pittsburgh, is contractor on the project.

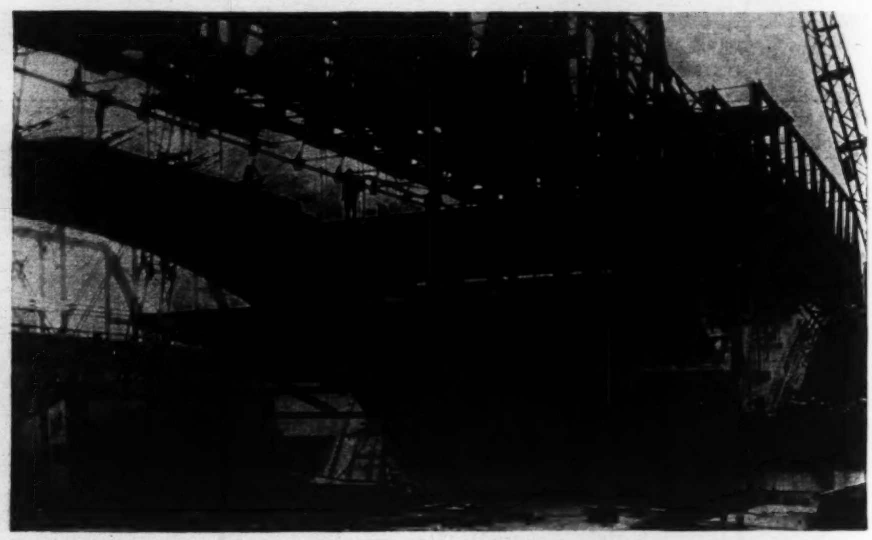


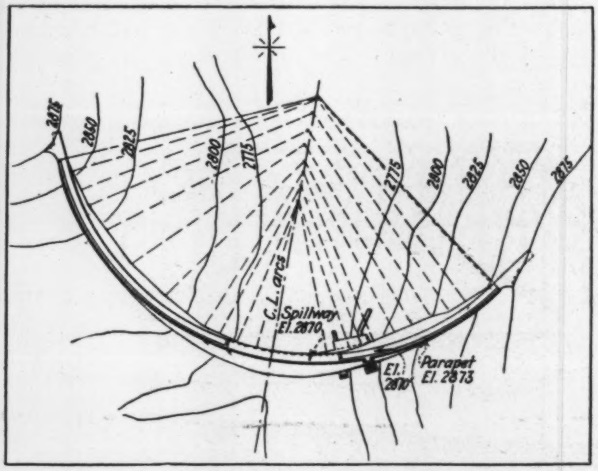
FIG. 4—ASSEMBLING ARCH CENTERING PANEL FORMS

Dam Design Provides for Deflection by Horizontal Hinge Joint

Variable-Radius Arch Has Contraction Joint 4 Ft. Deep in Upstream Face Along Base of Higher Portion

By D. C. Henny
Consulting Engineer, Portland, Ore.

A HORIZONTAL joint in the base of the upstream face is a novel feature of a concrete arch dam recently built near Ashland, Ore. The dam is a variable-radius arch, 112 ft. high, built to increase the water-storage capacity developed for the city of Ashland. To relieve excess shear and tension stresses in the arch, 55 tons of reinforcing steel amounting to 0.05 per cent of the total volume of the dam was distributed near the faces in addition to the use of the horizontal joint. Vertical construction joints were grouted about three months after completion of the dam, when the interior temperature averaged 44 deg. F., and after slowly filling during the past summer the measured deflection was found to be about one-half the calculated amount, with no leakage or cracks in evidence.



PLAN OF ASHLAND CREEK DAM

The water supply of the city of Ashland (6,000 population) is obtained from Ashland Creek, a small stream that originates in a steep mountain range to the west and flows through a narrow canyon which extends almost to the city. Streamflow varies from maximum flood of about 100 sec.-ft. to an average summer flow of about 5 sec.-ft.; the latter amount may diminish further to about 3 sec.-ft. during extremely dry seasons. Use of water for lawn sprinkling and some orchard irrigation produces a summer peak demand of about 380 gal. per capita per day, equaling a flow of about 3.5 sec.-ft. Prior rights to creek water amount to about 2 sec.-ft., making an equalized flow of 5.5 sec.-ft. necessary. The 800 acre-ft. of storage provided by this dam will satisfy this demand during the low-flow period and provide for a 50 per cent increase in population at the existing rate of use.

The dam is located about 3 miles west of the city in a federal forest reserve and the drainage area is closed to the public. Elevation of the dam site is considerably higher than that of the city, and failure of the structure would probably lead to serious loss of life. Flood danger is particularly serious, since the stream, below the mouth of the canyon, is carried through the town in a covered conduit.

Careful study was given to the geology. Hard, sound granite exists on the east bank and continues across the creek bottom and up on the west bank for a height of about 20 ft. Above this elevation on the west bank the granite is altered and crumbly in places, containing occasional seams of clay extending in some distance from the surface. Test pits and drifts showed that deep excavation was necessary to reach rock hard enough to serve as an abutment for an arch dam. The remote possibility that the clay-filled seams extended into the abutment rock beyond the concrete line controlled the design to some extent.

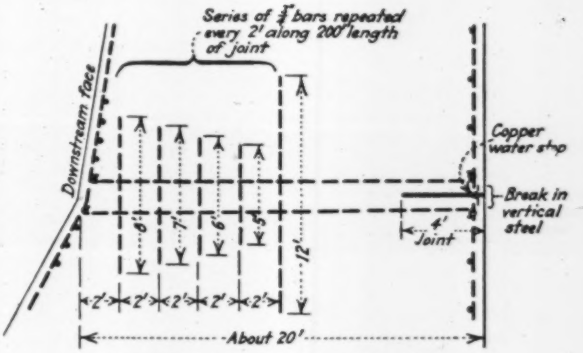
Actual excavation of the west abutment, which was carried about 100 ft. horizontally into the rock at midelevation, developed a harder and better quality of granite than was expected from the tunnel inspection. The seams of clay became thinner and less extensive as the excavation was deepened. Widths of the excavation were increased both upstream and downstream in several places to provide shoulders for the arch thrust. The rock at the end of the abutment trench was amply hard to take the thrust without more than ordinary elastic yielding. However, the entire trench was refilled with concrete to provide an artificial abutment that would aid in transferring arch stresses to the rock.

To insure a tight cutoff, grout holes from 5 to 10 ft. deep were drilled along the full length of the cutoff trench at about 10-ft. intervals. Grouting was done under 100-lb. pressure through pipes left in the base concrete; only a small amount of grout could be forced into the foundation rock.

The structure is an arch with radii varying from 230 to 158 ft. and a thickness of 7 ft. at the crest, increasing to 25 ft. at the base. The crest is 465 ft. long and a 110-ft. section near the center is lowered 4 ft. to provide an overflow spillway. Maximum compressive stress of the concrete allowed in the design was 625 lb. per sq.in., including allowance for drop in temperature.

Excessive tension and shear stresses were relieved by providing reinforcing steel as required, totaling 110,000 lb. Vertical steel was used to relieve the tension caused by beam action. Horizontal steel was introduced to aid in preventing buckling in the upper part of the dam in case of slight abutment yielding and to act as hoop steel near the base. For this reason it was run continuously through the contraction joints. This steel also caused the contraction joints to open uniformly during setting shrinking; hence all joints could be thoroughly grouted.

COMPLETED DAM WITH RESERVOIR FULL



DETAILS OF HORIZONTAL JOINT

The most unusual feature of design was the use of a hinge joint in the upstream face near the base to prevent horizontal cracking caused by deflection under load. This joint, which was provided along the 200-ft. length of highest section, was made by leaving a flat, smooth surface between pours to prevent adequate bond. It extends from the upstream face about 4 ft. into the dam. A copper water stop was provided along the joint about 6 in. back from the face. Back of the 4-ft. depth of joint the rest of the cross-section was roughened to secure good bond and was reinforced with vertical steel, as indicated in the accompanying sketch, to assist in taking the shear and to prevent the crack from opening further. The horizontal reinforcing on the upstream face is not affected by the horizontal joint. However, the vertical steel stops along this line, the bars below the joint being anchored into drill holes in the foundation rock. Similar anchoring was provided for all the vertical steel bars along the upstream face.

Vertical radial contraction joints were provided at 40-ft. intervals, reaching from crest to foundation. Felt was placed against the stepped sides of these joints to permit small relative movement of the blocks. Provision for grouting these contraction joints was made by placing horizontal pipes at 5-ft. intervals with outlets at the face of each in-and-out step. This horizontal pipe system (see sketch) consisted of the ordinary 1-in. iron pipe used for electrical conduits. The branches terminate at a beveled end in a common electrical outlet box with the open side against the face of the previous pour. This arrangement permitted escape of the thin grout but prevented plugging of the pipes by the concrete. The same system was repeated 5 ft. above after pouring the next lift, the end of each horizontal pipe extending out from the downstream face for connection with the grout hose.

Grouting was done with thin grout prepared in the mixer. The air tank consisted of a common domestic hot-water tank equipped with paddles and a crank for keeping the grout agitated. Beginning at the bottom, the grout hose was connected successively to each horizontal pipe end and air pressure applied until grout showed one or two lifts above. The pipe was then capped and attachment made at the next higher pipe. Loss of grout at the faces was prevented by lead wool calking.

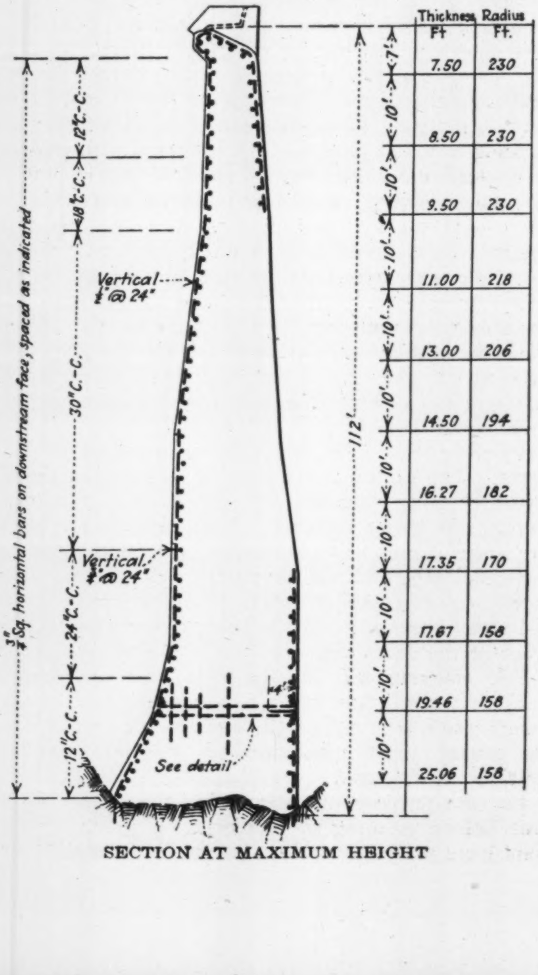
The concrete mix in the dam was approximately 1:2½:5, using gravel with a maximum size of 2½ in. Compressive strength of the concrete as determined by the testing plant maintained at the site was about 2,300 lb. in 28 days.

For the purpose of determining the proper lapse of time before grouting the construction joints, thermometers were placed at various points in the structure. At each of these locations several thermometers separated by felt washers were fitted into depressions in a wooden rod and inserted in a horizontal hole left in the concrete. Details of the method were described in *Engineering News-Record,* Dec. 11, 1924, p. 964, in connection with a similar installation at the Emigrant Creek dam. One row of five thermometers was located 15 ft. above the base, another row of five 56 ft. above the base and one of three at 95 ft. Temperature rise in the concrete was approximately 30 deg. F. Construction work was completed late in 1928, and in February, 1929, the thermometers indicated an average temperature in the concrete of 44 deg. F., which is below the average annual temperature. The radial contraction joints were grouted at that time.

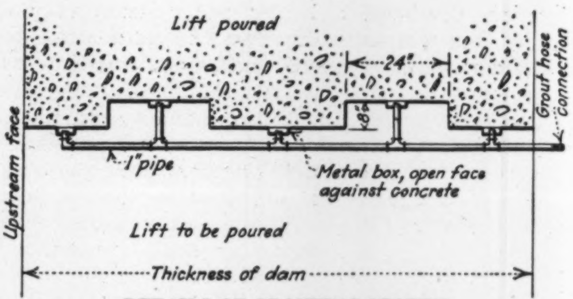
The reservoir filled slowly in April and May, 1929, and overflowed during June. Deflection measurements taken 5, 25, 45 and 65 ft. below spillway elevation on June 29 showed deflection of about 0.3 in. for all points measured. This deflection was practically one-half the amount estimated, the decrease being due probably to the thorough grouting and the low concrete temperature at the time of grouting.

No cracks have developed in the structure, and the slight sweating through the concrete that was apparent for a time has dried up. A small amount of leakage noticeable in the creek about 100 ft. below the dam probably comes through the rock abutment in spite of the foundation grouting.

F. C. Dillard was the engineer in charge of the work, with F. H. Walker as principal assistant. Detailed stress analysis of the design was made by G. Stubblefield, and geological studies were made by I. A. Williams, of Portland. A. J. Wiley was called in to pass upon the character of the abutments, and the writer acted as consulting engineer throughout the design and construction.



SECTION AT MAXIMUM HEIGHT



DETAILS OF GROUTING SYSTEM
This arrangement was repeated at 5-ft. vertical intervals in the vertical contraction joints provided at intervals of 40 ft.

English Sewage-Works Use Bleaching Powder as Auxiliary Treatment

BLEACHING powder has recently been used successfully at the sewage-works of Barnsley, England, to reduce the tendency to putrefaction in the Dortmund-type settling tanks which precede and follow the activated-sludge process. The aëration tank consists of eighteen channels totaling ¾ mile in length, in which skeleton paddles operate. The plant was designed for a dry-weather flow of 600,000 gal. (U. S.) a day and was put into use in December, 1924.

For the last year or so the plant has been receiving much stronger sewage than had been anticipated when it was designed, and as a result the final effluent was putrefactive a large part of the time. The application of bleaching powder to the sewage as it entered the plant was found to restrict septic action and allowed the plant to produce a stable final effluent. The dose of bleaching powder was such as to apply a little more than 8 parts per million available chlorine.

The experiences at Barnsley with this type of treatment were described by Herbert D. Bell, manager of the plant, in a paper presented before the Public Works, Roads and Transport Congress held in London on Nov. 21, and his remarks were extracted at length by *The Surveyor,* London, Nov. 22, 1929, p. 503.

State Court Upholds Plat-Filing Law

The provision of various New York State enabling acts giving cities, towns and villages the right to require municipal approval of subdivision plots before they can be legally filed with county clerks was upheld by the state Court of Appeals on Dec. 3, 1929 (Village of Lynbrook vs. George J. Cadoo et al.). The court ordered the county clerk to cancel the map in question, even though an official map of the village had not been adopted and filed. In the course of its opinion the court said: "Town planning is a new field of legislation, comparable with the recent development of zoning laws and regulations. Its purpose is to preserve through a governmental agency a uniform and harmonious development of the growth of a village and to prevent the individual owner from laying out streets according to his own sweet will without official approval."

Stress Formulas for Semi-Elliptical Sewers

Moment, Thrust and Shear Formulas for a Simplified Special Sewer Section Save Labor in Design—Applicable to Both Rock and Yielding Foundations

By Herman G. Dresser
Structural Engineer With Metcalf & Eddy, Engineers, Boston, Mass.

TO SIMPLIFY the laborious process of analyzing sewer sections the writer derived a set of formulas with which a man unfamiliar with arch analysis can analyze a semi-elliptical sewer section under symmetrical loading in two or three hours. The same problem would require at least two days of an experienced engineer's time if he employed the usual analytical and graphical method. Metcalf & Eddy's standard semi-elliptical section shown in Fig. 1 is the one for which these formulas are obtained. The property of this section that all dimensions depend directly on the diameter D makes the formulas possible.

Analysis—Cutting the section at the crown, Fig. 2, the structure may be considered as a curved beam acted upon by the known external forces and the unknown crown thrust, shear and moment, H_o, V_o and M_o. If these three unknowns are determined, the values of the moment, thrust and shear at any point in the ring are obtainable. Assume the half arch to be divided into thirteen voussoirs (though any other number may be taken), and let m be the bending moment (negative) at any voussoir center due to the external loads on the half arch. Also let N, V and M = thrust, shear and total moment at any voussoir center, ds = length of the voussoir along its mid-line, t = thickness of the voussoir at its center, I = moment of inertia of the voussoir at its center, W = the vertical external force acting on the voussoir, R = the resultant pressure in the masonry at the voussoir, x, y = co-ordinates (positive) of any point on the mid-line of the section referred to the crown as origin, m_y = moment at the voussoir due to 1 lb. acting vertically at the crown, m_x = moment at the voussoir due to 1 lb. acting horizontally at the crown, d_{1x}, d_{1y}, d_{1a} = horizontal, vertical and angular deflections at the crown due to 1 lb. acting vertically at the crown in the sense of V_o, Fig. 2, d_{2x}, d_{2y}, d_{2a} = horizontal, vertical and angular deflections at the crown due to 1 lb. acting horizontally at the crown in the sense of H_o, Fig. 2, d_{3x}, d_{3y}, d_{3a} = horizontal, vertical and angular deflections at the crown due to 1 ft.-lb. bending moment at the crown in the sense of M_o, Fig. 2, Δ_y = vertical deflection of the crown due to external forces, Δ_x = horizontal deflection of the crown due to external forces, Δ_a = angular change of face at the crown due to external forces.

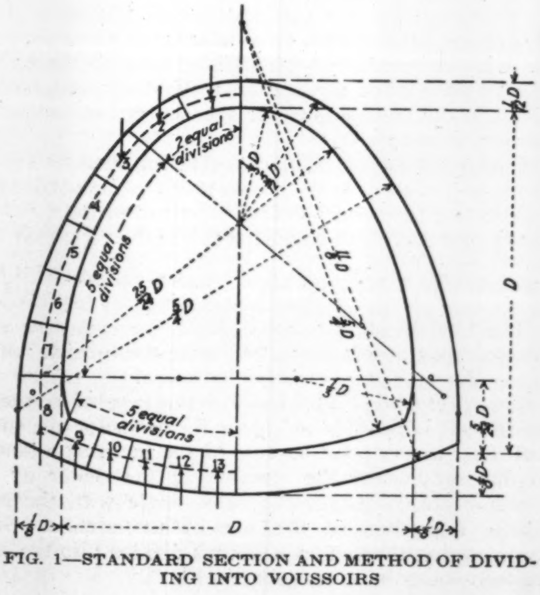


FIG. 1—STANDARD SECTION AND METHOD OF DIVIDING INTO VOUSSOIRS

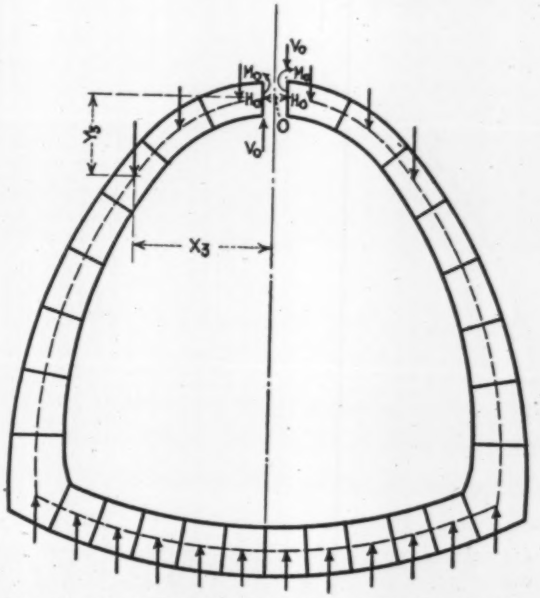


FIG. 2—FORCES IN EQUILIBRIUM ON THE SECTION

Assume that deflections to the left and downward are positive and that angular changes of face at the crown in a counter-clockwise direction are positive. Moments causing compression in the outer fibers are positive. A 1-ft. ring of masonry is considered.

The values of H_o, V_o, M_o must be such that, together with the effect of the external loads, the deflections of the right and left faces at the crown will correspond.

Equating the vertical, horizontal and angular deflections of the left and right half arches:

$$\Delta_y + V_o d_{1y} + H_o d_{2y} + M_o d_{3y} = \Delta_y - V_o d_{1y} + H_o d_{2y} + M_o d_{3y}$$

$$\Delta_x + H_o d_{2x} + M_o d_{3x} = -\Delta_x - H_o d_{2x} - M_o d_{3x}$$

$$\Delta_a + H_o d_{2a} + M_o d_{3a} = -\Delta_a - H_o d_{2a} - M_o d_{3a}$$

From the first equation, as well as from symmetry, it is evident that $V_o = 0$, therefore it is omitted from the

TABLE I—DIMENSIONS OF VOUSSOIRS OF SEMI-ELLIPTICAL SEWER SECTION

1 Voussoir No.	2 Thickness of Ring at Center of Voussoir, t, Ft.	3 ds, Ft.	4 Co-ordinates of Center of Each Voussoir x, Ft.	5 y, Ft.	6 Horizontal Projection of Extrados, Ft.	7 Vertical Load on Voussoirs W, Lb.
1	0.0833 D	0.1623 D	0.080 D	0.009 D	0.174 D	0.211 P
2	0.0833 D	0.1623 D	0.227 D	0.076 D	0.142 D	0.172 P
3	0.0851 D	0.1532 D	0.333 D	0.192 D	0.097 D	0.117 P
4	0.0897 D	0.1532 D	0.417 D	0.320 D	....	....
5	0.0968 D	0.1532 D	0.483 D	0.458 D	....	....
6	0.1050 D	0.1532 D	0.529 D	0.604 D	....	....
7	0.1157 D	0.1532 D	0.555 D	0.755 D	....	....
8	0.1384 D	0.1966 D	0.555 D	0.932 D	0.097 D	—0.078 P
9	0.1250 D	0.1034 D	0.456 D	1.022 D	0.102 D	—0.082 P
10	0.1250 D	0.1034 D	0.358 D	1.054 D	0.104 D	—0.083 P
11	0.1250 D	0.1034 D	0.257 D	1.078 D	0.106 D	—0.085 P
12	0.1250 D	0.1034 D	0.156 D	1.095 D	0.107 D	—0.086 P
13	0.1250 D	0.1034 D	0.053 D	1.103 D	0.108 D	—0.086 P

last two. Solving for H_o and M_o in the last two equations, we have:

$$H_o = \frac{\Delta_x d_{3a} - \Delta_a d_{3x}}{d_{2a} d_{3x} - d_{2x} d_{3a}}$$

$$M_o = \frac{\Delta_x d_{2a} - \Delta_a d_{2x}}{d_{3a} d_{2x} - d_{3x} d_{2a}}$$

Prof. C. W. Hudson in his book, "Deflections and Statically Indeterminate Stresses" (John Wiley & Sons, 1912), derives the general integral expressions for deflections of curved beams. The deflections necessary for H_o and M_o are: $\Delta_a = \Sigma\, m\, \frac{ds}{EI}$ taken as $\Sigma\, m\, \frac{ds}{t^3}$. Since $\frac{ds}{EI}$ appears in each term of the formulas for H_o and M_o, it has been shortened to $\frac{ds}{t^3}$.

$$\Delta_x = \Sigma\, m\, m_x\, \frac{ds}{t^3}$$

$$d_{2a} = d_{3x} = \Sigma\, m_x\, \frac{ds}{t^3}$$

$$d_{3a} = \Sigma\, \frac{ds}{t^3}$$

$$d_{2x} = \Sigma\, (m_x)^2\, \frac{ds}{t^3}$$

The dimensions in columns 2, 3, 4, 5 and 6 of Table I, expressed in terms of D, were calculated after taking measurements on a large-scale drawing of the standard section.

Loading—Some of the most recent investigations of loads on pipes indicate that, if the backfill is not thoroughly saturated and is placed without special compacting, the load is carried on the top quadrant of the section. This is because of the fact that the material arches from the center of the pipe to both sides of the trench. At certain voussoirs this type of loading will give more severe conditions than that of applying the vertical load over the full horizontal projection of the section, and introducing a horizontal thrust at each voussoir. One of the best methods of obtaining the load per linear foot of trench is that presented by Prof. Anson Marston and A. C. Anderson in Bulletin 31 of the Engineering Experiment Station, Iowa State College, and reprinted in the second edition of Vol. I of "American Sewerage Practice," by Metcalf & Eddy. The total load P per linear foot of trench obtained as noted above is assumed to be carried by six voussoirs at the crown and is distributed to them in proportion to the horizontal projection of the extrados of each. The load due to the concrete is neglected.

The bending moments due to the external loads on the curved beams are obtained as follows:

$$m_1 = 0$$
$$m_2 = w_1\ (x_2 - x_1)$$
$$m_3 = m_2 + \Sigma\ w_2\ (x_3 - x_2), \text{ etc.}$$

After the bending moments m_1, m_2, m_3, etc., have been calculated, we have sufficient information, together with that in Table I, to compute the deflections d_{3a}, d_{2x}, d_{2a} ($=d_{3x}$), Δ_a, and Δ_x. After making the necessary computations the following results are obtained. Taking summations for voussoirs 1 through 8:

$$\Sigma\ \frac{ds}{t^3} = d_{3a} = \frac{1496.74}{D^2}$$

$$\Sigma(m_x)\ \frac{ds}{t^3} = d_{2a}(=d_{3x}) = \frac{440.575}{D}$$

$$\Sigma(m_x)^2\ \frac{ds}{t^3} = d_{2x} = 237.047$$

$$\Sigma m\ \frac{ds}{t^3} = \Delta_a = -129.425\ \frac{P}{D}$$

$$\Sigma(mm_x)\ \frac{ds}{t^3} = \Delta_x = -62.948P$$

Summations for voussoirs 1 through 13:

$$\Sigma\ \frac{ds}{t^3} = d_{3a} = \frac{1761.44}{D^2}$$

$$\Sigma(m_x)\ \frac{ds}{t^3} = d_{2a}(=d_{3x}) = \frac{723.910}{D}$$

$$\Sigma(m_x)^2\ \frac{ds}{t^3} = d_{2x} = 540.558$$

$$\Sigma m\ \frac{ds}{t^3} = \Delta_a = -153.200\ \frac{P}{D}$$

$$\Sigma mm_x\ \frac{ds}{t^3} = \Delta_x = -88.154\, P$$

Reactions—Two cases are to be considered in the derivation of the formulas. Case I considers the arch and side wall only; it is used when the section is built on solid rock so that all the load goes straight down from the side walls into the rock and is not distributed over the base. For this case the summations to obtain the deflections are only carried through voussoir 8. Case II considers the section as an elastic ring and assumes the total load uniformly distributed over the base; this case is used when the section is built on compressible soil, and the summations for the deflections include all thirteen voussoirs.

Crown Thrust and Moment—The expressions for the thrust and moment at the crown may now be obtained by substituting the proper deflection values in the formulas for H_o and M_o. The simplified values thus obtained are:

$$\text{Case I} \begin{cases} H_o = 0.231\ P \\ M_o = +0.0183\ PD \end{cases} \qquad \text{Case II} \begin{cases} H_o = 0.104\ P \\ M_o = 0.0444\ PD \end{cases}$$

The total bending moment M at the center of each voussoir may now be computed using the formula: $M = m + M_o + H_o y$.

Forces at Any Voussoir—For the type of section in question it is possible to obtain formulas for the thrust and shear at any point because of the fact that a tangent to the mid-line of the masonry at the center of any voussoir always makes the same angle with the horizontal, regardless of the size of the section. It is assumed that the section is always divided into the same thirteen voussoirs as indicated in Fig. 1.

TABLE II—FORMULAS FOR MOMENT, THRUST AND SHEAR—CASE I

Voussoir No.	Moment, Ft.-Lb.	Thrust, Lb.	Shear, Lb.
Crown	$+0.0183\,PD$	$0.231\,P$	Zero
1	$+0.0204\,PD$	$0.270\,P$	$0.157\,P$
2	$+0.0049\,PD$	$0.415\,P$	$0.165\,P$
3	$-0.0089\,PD$	$0.538\,P$	$0.116\,P$
4	$-0.0213\,PD$	$0.549\,P$	$0.043\,P$
5	$-0.0225\,PD$	$0.550\,P$	$0.031\,P$
6	$-0.0118\,PD$	$0.541\,P$	$0.105\,P$
7	$+0.0102\,PD$	$0.522\,P$	$0.175\,P$
8	$+0.0510\,PD$	$0.444\,P$	$0.186\,P$

P equals the total load per linear feet of trench.

TABLE III—FORMULAS FOR MOMENT, THRUST AND SHEAR—CASE II

Voussoir No.	Moment, Ft.-Lb.		Thrust, Lb.	Shear, Lb.
Crown	$+0.0444\,PD$		$0.104\,P$	Zero
1	$+0.0453\,PD$		$0.146\,P$	$0.184\,P$
2	$+0.0213\,PD$		$0.314\,P$	$0.242\,P$
3	$-0.0072\,PD$		$0.462\,P$	$0.217\,P$
4	$-0.0359\,PD$		$0.487\,P$	$0.153\,P$
5	$-0.0546\,PD$		$0.503\,P$	$0.087\,P$
6	$-0.0624\,PD$		$0.510\,P$	$0.018\,P$
7	$-0.0597\,PD$		$0.508\,P$	$0.049\,P$
8	$-0.0413\,PD$		$0.431\,P$	$0.060\,P$
9	$+0.0099\,PD$		$0.021\,P$	$0.355\,P$
10	$+0.0465\,PD$	Tension	$0.030\,P$	$0.276\,P$
11	$+0.0750\,PD$		$0.068\,P$	$0.189\,P$
12	$+0.0942\,PD$		$0.093\,P$	$0.098\,P$
13	$+0.1039\,PD$		$0.104\,P$	Zero

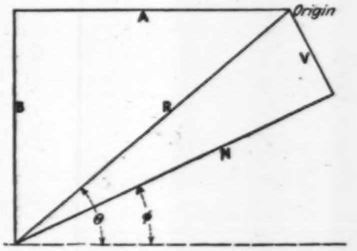


FIG. 3—RESOLUTION OF FORCES ON GIVEN VOUSSOIR

Formulas for the thrust and shear are obtained in the following manner: In Fig. 3 the value of A, the horizontal component of R, the resultant pressure, for any voussoir will equal the crown thrust H_0. The vertical component B is equal to the sum of the external vertical loads on the voussoirs up to and including the one in question. N is parallel with a line tangent to the midline of the masonry at the center of the voussoir, and V is perpendicular to it. The angle ϕ for each voussoir was determined from the large-scale drawing. The thrust N is $R\cos(\theta - \phi)$. But $\cos(\theta - \phi)$ $= \cos\theta\cos\phi + \sin\theta\sin\theta = \frac{A}{R}\cos\phi + \frac{B}{R}\sin\phi$, or,

$$N = A\cos\phi + B\sin\phi.$$

In the same way the shear, $V = B\cos\phi - A\sin\phi$.

Using this method and the general expressions for the components A and B, the formulas have been obtained for thrust and shear at all the voussoirs for both cases. These are given in Tables II and III.

Several things are to be noted in the use of these formulas. Case I should never be used unless the sewer is built on rock. In some cases with heavy loading it will be found that the thickness of concrete in the standard section is not sufficient. Under those conditions it is possible within narrow limits to increase the thickness of concrete, using the same moment, thrust and shear. For very heavy loading and an appreciably thicker section, the usual method of analysis should be employed.

Formulas applicable to both vertical and horizontal loading on the sides and crown, computed by the writer, appear in Metcalf & Eddy's "American Sewerage Practice," Vol. I, second edition. At certain voussoirs the two types of loadings show reversals of stress—that is, tension in opposite faces of the masonry. If there is doubt as to the expected loading, both sets of formulas should be used and the section designed for the worst condition at each voussoir.

Allentown Viaduct Repaired by Welding and Guniting

Tilghman St. Bridge Can Now Carry Modern Highway Traffic Safely—Savings in Time Bridge Was Out of Service and in Cost Over a New Structure

By E. W. Meckley
City Engineer, Allentown, Pa.

An interesting example of the adaptation of modern methods in strengthening an old highway bridge for modern traffic requirements has been carried out in Allentown, Pa., where the city, in co-operation with the state highway department and the officials of Lehigh County, recently completed the reinforcing of a steel bridge over the Lehigh River on Tilghman St. to serve as an additional inlet to the city from the east and also to act as a bypass for through traffic from the already congested central section of the city.

In developing this new artery for traffic the city was confronted with the problem of reconstructing an old

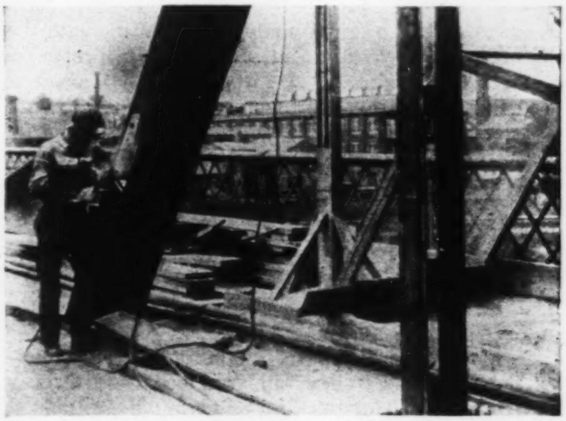


FIG. 1—WELDING AN ANGLE TO THE SIDE OF THE END POST, TILGHMAN STREET VIADUCT, ALLENTOWN, PA.
Note also the flat added to the side of the vertical hangar.

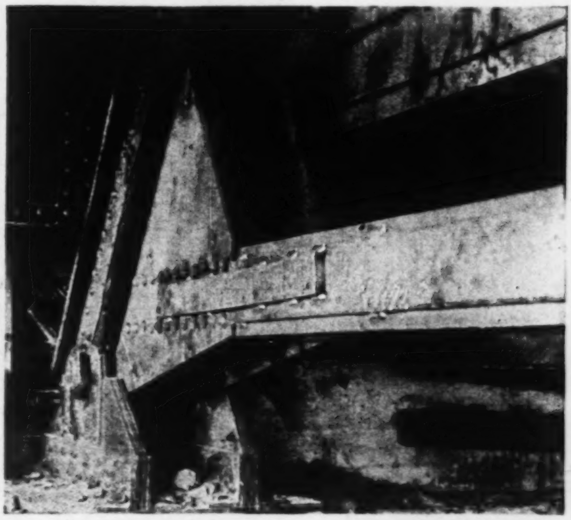


FIG. 2—WELDED REINFORCING ON LOWER CHORD
Flat steel was butted against the gusset plate, forming the connection at the bearing joint. Notice also splice plate added for further stiffness.

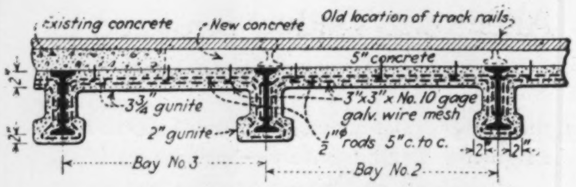

Existing concrete
New concrete
Old location of track rails
5" concrete
3¼" gunite
2" gunite
3"x3" x No. 10 gage galv. wire mesh
½" rods 5" c. to c.
2"
2"
Bay No 3
Bay No 2

FIG. 3—GUNITE STRENGTHENING OVER RAILROAD TRACKS

All bays except No. 3 similar to No. 2. Bay No. 3 is continuous for full length of bridge.

steel viaduct, consisting of a series of deck-truss, through-truss and girder spans constructed in 1908. The roadway carried a trolley line with rails resting on two lines of stringers. The through-truss spans are over the tracks of the Lehigh Valley Railroad and the Jersey Central Railroad. Realizing that the volume and character of traffic that would be thrown over this structure would be far in excess of that anticipated on the original design, the writer had an analysis made of the structure from the viewpoint not only of adding strength but also of protecting it against the severely corrosive condition over the railroad due to the gases from the locomotives and to the abrasive action of the exhaust blasts.

The plan of the original analysis was to increase the strength of the floorbeams and stringers by a protective coat of reinforced gunite. A further analysis, however, showed that the various members of the trusses themselves needed considerable additional steel to insure their safety. It was decided to add this steel by welding flats or angles of sufficient size to each member. In Fig. 4 is depicted a truss diagram showing the details of this strengthening program.

The new steel was securely clamped against the old steel surface which previously had been thoroughly cleaned by sandblasting. Welds were spotted at the designed spacings.

The gunite strengthening brought out several interesting details. The trolley rails had been laid directly on two lines of stringers. In removing these rails it was necessary to cut out the concrete floor slab for at least 2 ft. from the rail, leaving a very unsafe condition. It was therefore decided to reinforce this particular bay by building a gunite slab of semi-arch section underneath this concrete joint for the full length of the structure. The details of this arch are shown in Fig. 3. By adopting this method it was necessary to remove only that portion of the concrete which had been broken and weakened by the severe vibration of the street cars.

The slabs over the railroad had been affected by the action of the locomotive gases, and it was decided to reinforce these by adding a flat slab of gunite to the bottom of the concrete slabs. To determine the thickness and amount of reinforcing, the existing concrete slab was assumed as having one-half of the value sufficient for modern conditions. Fig. 5 shows how the rods were bent and placed to throw the load directly into the flanges of the beams. Over these rods a layer of reinforcing fabric was placed to insure against possible cracking of the reinforcing and to give a better distribution of the loads.

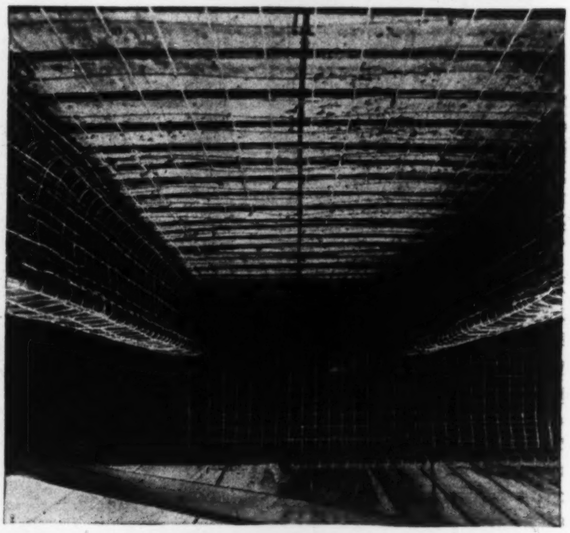


FIG. 5—REINFORCING STEEL SHOWING HOW RODS ARE BENT TO THROW LOAD DIRECTLY INTO BEAM FLANGES

In carrying out this work it was necessary to use the utmost care in properly cleaning the steel and concrete surfaces against which either welding or gunite had to be applied. The writer feels that the success of the operation has amply justified the belief that these methods would not only effect great financial saving but would insure an occupancy of the structure approximately one year earlier than possible if the bridge had been rebuilt. The contract for the entire renovation of this 900-ft. viaduct was let on July 6 and the bridge was completed and ready for traffic on Sept. 1, 1929.

The design and supervision of these repairs has been under the direction of the writer, and the work has been done by the contracting department of the Cement Gun Co., Inc., Allentown, Pa.

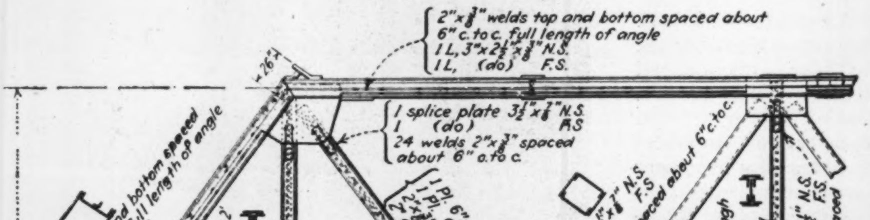

2"x⅜" welds top and bottom spaced about 6" c. to c. full length of angle
1 L, 3"x2½"x⅜" N.S.
1 L, (do) F.S.
26"
21'
1 splice plate 3½"x⅞" N.S.
1 (do) F.S
24 welds 2"x⅜" spaced about 6" c. to c.
2"x⅜" welds top and bottom spaced about 6" c. to c. full length of angle
1 L, 3"x2½"x⅜" N.S.
1 L, (do) F.S.
1 splice plate 3½"x⅞" N.S.
1 (do) F.S
24 welds 2"x⅜" spc'd about 6" c. to c.
2"x⅜" welds spaced about 2' c. to c. full length
1 Pl. 4"x⅜" N.S.
1 Pl. (do) F.S.
1 splice plate 3"x½" N.S
1 (do) F.S
16 welds 2"x⅜" spaced about 6" c. to c.
1 Pl. 6"x½" N.S
1 Pl. (do) F.S.
2"x⅜" welds spaced about 2' c. to c. full length
1 splice plate 3½"x⅞" N.S
1 (do) F.S
24 welds 2"x⅜" spaced about 6" c. to c.
2"x⅜" welds spaced about 2' c. to c. full length
1 Pl. 4"x⅜" N.S.
1 Pl. (do) F.S.
2"x⅜" welds spaced abt. 2' c. to c. full length
1 Pl. 9"x½" N.S.
1 Pl. (do) F.S.
1 splice plate 3"x½" N.S
1 (do) F.S.
16 welds 2"x⅜" spaced about 6" c. to c.
2"x⅜" welds spaced about 2' c. to c. full length
1 Pl. 6"x½" N.S.
1 Pl. (do) F.S.
New plates welded to present gusset plates, splice plates welded full length bottom chord both sides
Sym. about center line except as shown
C.L.
15'
15'
15'

FIG. 4—METHOD OF STRENGTHENING VIADUCT TRUSS BY WELDING, ALLENTOWN, PA.

Unsolved Garbage Disposal Problem at San Francisco

Despite Many Years of Endeavor to Make Improvement, the Overloaded Destructor, Now 35 Years Old, Remains Sole Means of Disposal

THE PROBLEM of what to do with 600 tons of garbage daily has been acute in San Francisco for many years. Despite the fact that the aged, overloaded destructor is unable to meet present demands effectively and although the volume of garbage to be handled steadily is increasing, there is today little more prospect for an early solution of the problem than there has been at any time in the past decade.

The muddle is not attributable to any lack of engineering consideration. The city engineer long has been favorable to disposal by incineration. After the board of supervisors decided to adopt this method he made a trip to examine incinerators in all parts of the United States and on his return recommended certain types of plants that he believed suited to San Francisco's needs. Not that the exact type by any means has been agreed upon (even the question of whether the householder should be obliged to segregate combustible and non-combustible refuse is still unsettled) but the incineration method has been sufficiently well studied so that the cost of the plant needed has been placed at about $1,000,000.

Apparently it has been the $1,000,000 cost of the incinerator at which the city fathers have balked. At any rate, the board of supervisors has shown great reluctance to call an incinerator bond election, there being a widespread belief that the necessary two-thirds vote for such a measure could not be obtained.

The garbage collection situation, likewise, is complicated. The more so because of amendments from time to time to the garbage ordinance after disputes between scavengers and the city or among the scavengers themselves. The ordinance now fixes the collection rate for flats, residences and apartments and leaves to the scavengers themselves determination of rates for restaurants and hotels. This separate classification is because of the value to hog raisers of the table waste from hotels and restaurants. For hotel and restaurant service, the ordinance allows new operators to enter the field in competition with scavengers already serving a territory wherever individuals or firms from whom the collections are made approve the application for a new permit. In this way the Scavengers' Association is prevented from controlling hotel and restaurant collections.

In an endeavor to solve the problem of securing a suitable plant for incineration, suggestion has been made that the city encourage the Scavengers' Association to build a new incinerator which the city would agree to purchase on the installment plan. This was found not feasible because of limitations in the city charter; although a recapture clause in any operating permit would be legal, the charter provision which relieves any board of supervisors from responsibility for making payment on any contract entered into by a previous board, would invalidate any long-time purchase agreement.

Failing in this, it has been suggested that perhaps the Scavengers' Association might be induced to finance and construct on its own account an incinerator which it would operate for a reasonable return. Here, again, is a legal difficulty; under the city ordinance the operators of the city's incinerator, whoever they may be, must receive and burn, at $1 a ton, the refuse delivered to it by any and all scavengers. Although the Scavengers' Association has thus far succeeded in operating the incinerator at this rate of pay, experience in other cities indicates that any modern incinerator would involve an operating cost exceeding $1 per ton.

This might be remedied, it would seem, by changing the ordinance. However, the voters, naturally, will oppose any move to raise the charges and the scavengers cannot among themselves agree to a higher collection charge that would pass on to the public the increased incinerator cost, because not only are the collection rates in most parts of the city fixed by ordinance but, under the ordinance, independent operators who did not share in the cost of incinerator operation always could offer the householder lower rates if the association loaded collection charges with incinerator costs.

Meantime, the old Thackeray destructor built 35 years ago and designed for a capacity of 400 tons per 16 hr., is bravely doing its best, but with patched up walls, insufficient storage space and inefficient combustion it is laboring and smoking under a terrific overload in attempting to handle 600 tons in two 9-hr. shifts.

Because of the smoke and smell, property owners in the vicinity nearly three years ago took into court the claim that the destructor is operated as a public nuisance. The court found the incinerator to be a nuisance but the injunction ordering the city to discontinue its operation is being held in abeyance pending action by the board of supervisors in remedying its deficiencies, or building a new incinerator or adopting some other means of disposal.

Last November, the voters approved disposal by incineration but at the same time negatived their vote by declaring against either municipal or private construction of an incinerator. This was on a mere "opinion" vote, not legally binding on the authorities. At the same time the voters defeated an initiative ordinance, which would have been mandatory if approved, calling for disposal by the fill-and-cover method.

Ultimately, some way out of the dilemma will be found but what it will be is not now apparent. Meanwhile a serious municipal problem is dragging along, wholly unsolved and without any feasible solution in sight. The board of supervisors, as constituted at the beginning of this year, contains six new members and there is hope that this may bring into the picture new life and action. One thing the supervisors might consider—a possibility that the court might also take cognizance of—is whether it is worthwhile, as partial relief of the present plant, to put in condition and use the "new" incinerator completed and tested in 1914, rejected by the city as not complying with the contract but finally accepted and paid for in accordance with a court decision late in 1917 (see *Engineering News*, Nov. 26 and Dec. 10, 1914, pp. 1096 and 1190, and Feb. 1, 1917, p. 209). For more recent information on the San Francisco garbage and refuse situation see *Engineering News-Record* as follows: March 3, 1927, p. 346; April 14, 1927, pp. 624 and 627; July 21, 1927, p. 86; Feb. 28, 1929, p. 364; Sept. 26, 1929, p. 511; Oct. 10, 1929, p. 559; Nov. 14, 1929, p. 786.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Cleaning Le Chatelier Flasks

By Harry Tucker
Professor of Highway Engineering,
North Carolina State College of Agriculture and Engineering,
Raleigh, N. C.

THE CHATELIER specific gravity flasks are difficult to clean because of the small graduated stem. When testing portland cement, benzine or kerosine is used in the flasks so that the cement will not "set up" and prevent the use of the bottle again. If inadvertently a few drops of water should get in the flask, particles of cement will adhere to the inside, and it is almost impossible to remove these by the usual methods.

I have found that these cement particles can be cleaned out very thoroughly with the use of sand. A small quantity of coarse sand (Ottawa sand is usually available and convenient) is poured into the flask with a little kerosine and the flask is shaken vigorously. Unless the cement has been allowed to set up completely, it will be found that this method will prove quite effective.

Building a Trucking Subway Under a Busy Street

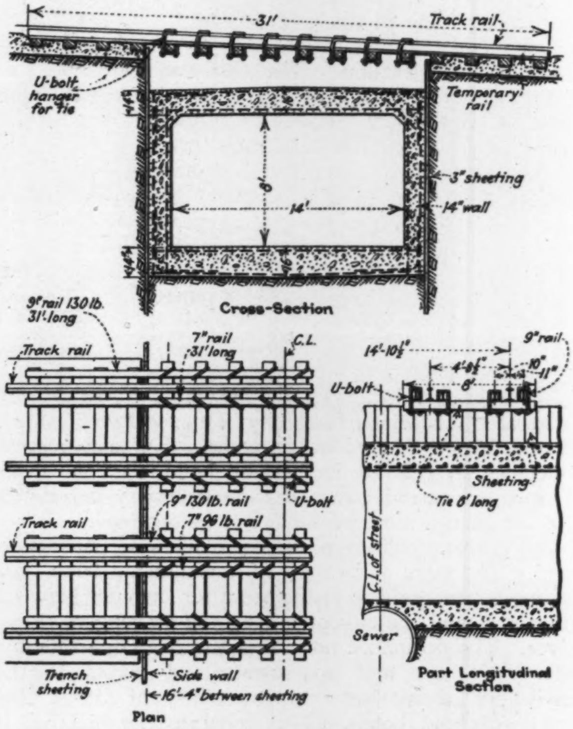
By J. D. Levin
Engineer, Wells Brothers Construction Company,
Milwaukee, Wis.

WITH the construction of an eight-story office building for Montgomery Ward & Company, Chicago, it was necessary to provide a trucking subway about 60 ft. long under Chicago Ave. to connect the new basement with that of the company's warehouse on the opposite side of the street. This subway (Fig. 1) was built in open cut in two sections, so that half of the roadway was kept clear for vehicular traffic, and both car tracks were kept in service all the time, as this is a heavy-traffic thoroughfare.

To carry these tracks across the excavated portion of the street, as shown in the figure, old grooved rails were laid on each side of each track rail, their length being such that their ends rested on the ties in the undisturbed part of the track. Hangers or 1½-in. U-bolts straddling the temporary rails diagonally carried bearing plates which supported the wood ties, being held by nuts on the legs of the hangers, as shown. Although this manner of supporting rails is more or less common in railroad work, its application under the conditions noted was rather unusual.

This reinforced-concrete subway, 14x8 ft. inside, has 16-in. floor and roof and 14-in. walls, the width of trench between the sheeting which served as the side forms being about 17 ft. A water main was siphoned to pass under it, and the roof of a sewer was partly embedded in the concrete floor. Telephone conduits extending diagonally across the street were embedded in the roof, being supported by two steel angles resting on the side walls. The part of the roof thus weakened was reinforced under the car tracks by four I-beams.

Trench timbering, which served as the outside formwork, consisted of 3x12-in. sheeting and 8x8-in. wales, all of which was left embedded in the concrete, with the exception of the upper waling pieces. Concrete was a 1:2:4 mix, transported in buggies from a ½-yd. mixer located on the building lot, about 100 ft. from the subway. Excavation, which was largely in firm clay, was done by compressed-air spades. Day and night crews helped to rush the construction, but six weeks was required to complete it because of the handicaps under which the work was done and because of the time required by the city and the public utilities having work in conjunction with the subway.



TRUCKING SUBWAY UNDER CHICAGO STREET
Showing method of support car tracks.

To insure a substantial waterproof joint, the side walls were thickened or winged out at the connection with the basement walls of the old building. Both sheet copper and bonding keys were used to make a watertight connection at the juncture of the two halves of the tunnel. To make the walls and floor waterproof, 10 per cent, by weight, of hydrated lime was added to the concrete, and after the work was completed the floor was further waterproofed by the application of a liquid floor surfacing. For the roof, four layers of roofing felt in five layers of hot pitch, with a burlap covering over the last layer of pitch, constituted the waterproofing over the concrete. This covering was then sealed with a 3-in. concrete slab, and covered with a crushed-stone fill to support the tracks.

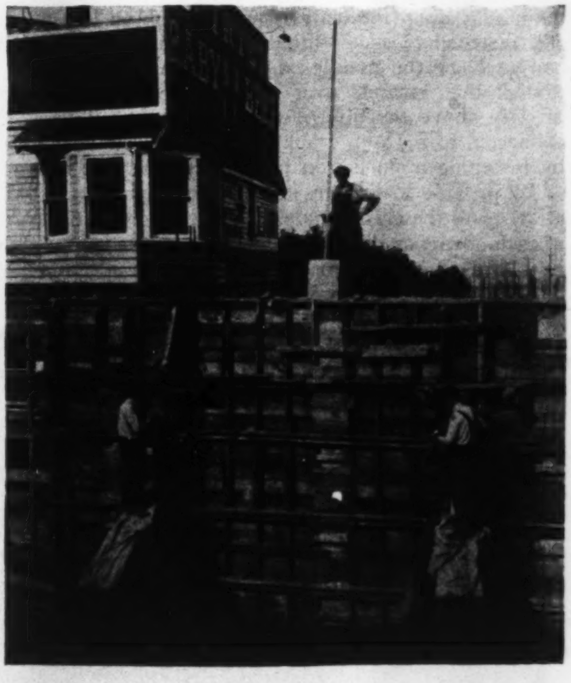
As soon as the forms were removed and while the concrete was still green, the interior face of the walls and ceiling was rubbed with carborundum stones and water to remove form marks and unevenness. Imperfectly filled portions were patched with a 1:2 cement mortar which was surfaced with wood floats, the entire surface being then finished with a rich cement grout.

This subway was designed by S. E. Berkenblit, structural engineer for the construction department of Montgomery Ward & Company, of which W. H. McCaully is chief engineer. The contractor was the Wells Brothers Construction Company, Chicago, with E. J. Wheeler as superintendent.

Concrete Placed in Thin, High Wall by Scheme Resembling the Tremie

IN A grade-separation project on Harbor Ave., in Seattle, Wash., it was necessary to build a thin retaining wall of 23-ft. maximum height. The face of the wall fronts on a thoroughfare, and therefore a smooth finish of good appearance was particularly desirable. Layers of ½-in. round reinforcement, both horizontal and vertical, were required on both sides of the wall, with a 1-in. cover of concrete over the steel. The total thickness of the wall being but 9 in. and there being but 5-in. clearance between the two layers of reinforcement, it would have been difficult to pour the concrete in the usual way with assurance that good placement and a smooth finish would be obtained. A simple construction scheme therefore was devised, as described in the following.

The wall is 140 ft. long, including the wing that makes the structure L-shaped in plan. On the exposed face, pilasters are spaced on 13½-ft. centers, and on the reverse side, opposite the pilasters, 6-in. tie walls extend back into the hill to connect with a 6-in. anchor wall paralleling the main wall.



REAR OF RETAINING WALL SHOWING PLACEMENT SCHEME
Tremies formed by boarding over an occasional pair of studs. Note openings and headers, also baffle on rod at top.

Wooden forms were built up in the ordinary way for the full height of the structure, using 2x6-in. vertical studs about 18 in. on centers. Concrete was delivered to the wall in buggies on a runway around the top of the forms. Instead of dumping into the wall proper, however, these buggies delivered through portable wooden throats or hoppers into shafts on the back of the wall which had been made by boarding over on their edges certain pairs of the 2x6 studs. The studs, the shiplap of the wall form, and the additional boarding thus formed a rectangular shaft or tremie, approximately 6x16 in. in size.

OUTER FACE OF THE TREMIED WALL
Pilasters on 13½-ft. centers. Far end of wall makes right-angle bend.

After dropping down to the desired level in this tremie the concrete passed into the wall through a temporary opening made by removing a section of one of the form boards between the two studs. A piece of 2x6, nailed in between the studs, constituted the bottom of the tremie. When the concrete had filled the forms to the level of the bottom of the tremie, a new opening into the wall was made at a level 4 or 5 ft. higher, where a new 2x6 header or stop was nailed in between the studs. The lower opening into the wall was then closed and the pouring of the concrete was resumed.

A buggy-load of concrete, discharged into the tremie, was checked by the 2x6 header and diverted into the wall, a considerable column of soft concrete temporarily standing in the shaft or tremie. To prevent too violent entry into the wall, with spattering and separation of the aggregate, an essential part of the scheme was a baffle board with a long 2x3 handle, held directly inside the wall form and against the incoming flow of concrete. In general two tremies were used in each of the 13.5-ft. bays between the pilasters.

By using this scheme it was possible to complete the entire walls in a single pour without the expense of raising the formwork in sections or the delays and uncertainties involved in different tamping for compaction. As a matter of fact, very little tamping or hammering of forms was necessary, the resultant faces of the concrete being found, when the forms were stripped, to have a remarkable uniformity and smoothness of finish and complete freedom from gravel pockets. The mix used was 1 : 2 : 3.

The work is being done under the direction of Clark H. Eldridge, junior bridge engineer, Seattle, Wash. L. H. Huglen was inspector in charge of the work, and Hans Pederson was the contractor.

48-In. Concrete Pipe Jacked Through Natural Ground Under Three Tracks

By S. W. Worthington

Engineer, Rochester & Lake Ontario Water Service Corporation, Rochester, N. Y.

IN THE recent construction of a 20-in. water main crossing under a three-track railroad line, the railroad company insisted on some kind of a protection or covering for the main, placed at least 4 ft. below base of rail. Building a box culvert in an open cut, with the necessary supporting of track, had previously proved to be an expensive operation, so in this case it was decided to try jacking a 48-in. reinforced-concrete pipe under the tracks and lay the water main inside this casing. The economy of the jacking method well justified its use.

The pipe line did not cross through an embankment, but through undisturbed, hard, blue glacial clay, free from stones. An open pit was dug adjacent to the tracks, as shown in Fig. 2, and a heavy timber cradle was placed in this cut, carefully aligned and leveled, and held in place by stakes. Pipe sections were rolled over the pit on two 8x8-in. timbers, picked up in a sling by a chain hoist from a gallows frame and lowered onto the cradle. An opening in the cradle permitted easy removal of the sling.

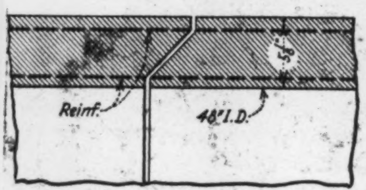


FIG. 1—PART LONGITUDINAL SECTION OF PIPE, SHOWING TYPE OF JOINT USED

The 48-in. concrete pipe was reinforced with two layers of wire mesh, had a wall thickness of 5⅛ in., and and was provided with tongue-and-groove joints, shown in Fig. 1. The pipe sections, 4 ft. long, weighed 3,500 lb. each. A total of 60 ft. of pipe was placed, 12 ft. in open cut and 48 ft. by jacking. Two 15-ton ratchet jacks were used for the first 40 ft., then were replaced by two 50-ton jacks, arranged as shown in Fig. 2, jacking against a single timber placed across the pipe, one-third of its height above the bottom.

Excavating ahead of the pipe was done with pneumatic clay spades because of the hardness of the material. But because of the stable condition of the material it was possible to excavate 4 ft., or one full pipe length, ahead of the pipe, thereby permitting the jack and blocking to be kept out of the way during the excavation period. The passage of trains had no effect on the excavated area in front of the pipe. Pipe joints were pointed up with mortar from the inside.

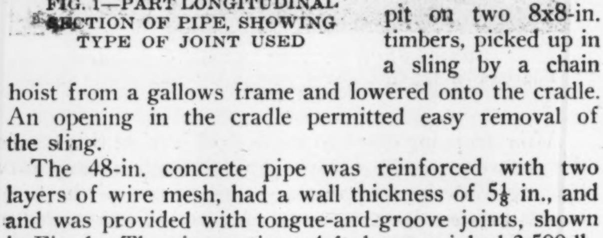


FIG. 2—LAYOUT FOR JACKING 48-IN. CONCRETE PIPE UNDER THREE TRACKS

A foreman and five laborers composed the crew. Two men worked inside the pipe, one operating the air spade and the other shoveling excavated material back through the pipe. Another laborer shoveled the dirt out of the cut, and a truck driver and helper loaded it onto a truck. About 45 minutes was required to roll a piece of pipe over the pit, lower it to the cradle and jack it into place. Thirteen working days were required to complete the job, including the digging of the jacking pit. The total labor cost was $668.42, distributed as follows:

	Man-Hours	Cost
Excavation	625	$448.36
Placing pipe	203	145.38
Removing dirt	35½	58.58
Backfill	23	16.10
Total	886½	$668.42

The average wage was 71.3c. per hour. The costs include use of the air compressor and truck.

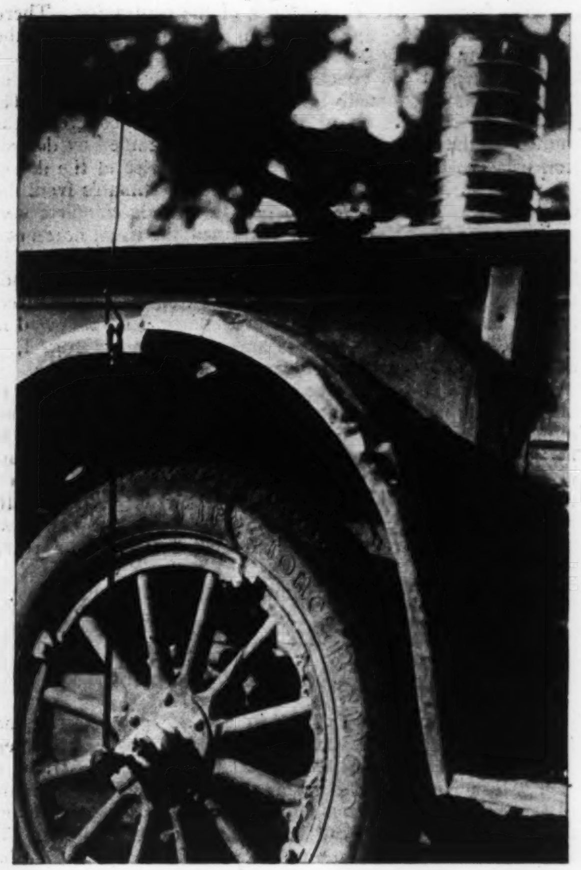
Improvised Sieve Shaker Aids Field Testing of Road Materials

TO LESSEN the time required for hand sieving the many field samples of surfacing material tested during the construction of oiled roads, a mechanical shaker was devised and used extensively on a job of the New Mexico State Highway Department. Better results have been obtained in long series of tests by using this device, because in hand sieving the tester is apt to become tired and careless. The shaker was built of scrap material from around the job, which accounts for its crude appearance.

The arrangement consists of a light wooden cradle extending across the body of a small commercial roadster and actuated by power takeoff from one of the rear wheels jacked up off the ground. The cradle is built of lath to a width of about 1 ft. and a length sufficient to span the body. A tin pan, large enough to contain the sieves, is nailed to the cradle in the center. Shifting of the cradle along the body is prevented by a lath at each end fastened to stakes fitted in holes in the side of the body. Near the middle of this framework is fastened a stick that extends over the side with the outer end directly above the hub of the rear wheel. This end is connected to a 1½-in. crank arm on the rear wheel made by fastening a small iron plate under the axle nut.

To provide a definite jolt during sieving, a board is attached to the cradle under the sieves to strike the floor at each downward stroke. The down stroke is accelerated by a coil spring fastened between the cradle and floor, as shown in the accompanying illustration.

SIEVES ON CRADLE READY FOR SHAKING
The coil spring accelerates the downward motion that ends with a jolt when the board strikes floor.



POWER TAKEOFF FOR SHAKING
Motion from 1½-in. crank arm transmitted to sieves on cradle.

Operating procedure consists of placing the set of 8-in. laboratory sieves in the pan and fastening them in position by a leather strap running under the cradle. The rear wheel is then jacked up and the motor is started and set at the proper speed. The result is an efficient and thorough sieving of the sample. This arrangement was devised and constructed by H. W. Rice, of the New Mexico State Highway Department.

Letters to the Editor

Accuracy and Economy of Proposed Concrete Test Questioned

Sir—In the issue of Nov. 28, 1929, p. 846, there is an article entitled "A Substitute for the Compression Test of Concrete." The method described is unnecessary, inaccurate, includes unfounded assumptions and is misleading in its claim of economy. Its thesis is that by separating a sample of newly-mixed concrete into its elements of water, cement, sand and rock, and then comparing the water-cement ratio thus found to the general theoretical value set up by Abrams, the 28-day strength can be "economically, quickly and closely fixed."

The testing method described by the author will be found to consist of fully 33 separate operations, so that the claim of economy is questionable. Also, there are serious sources of error which make the weights—recorded in millionths of a pound!—ridiculous. Some are: Loss of part of sample; stirring with hands (some may adhere to fingers); loss of decanted liquid or carrying over of sand; loss of cement and fine sand adhering to paper; some cement may be poured over; heat may drive off some fine cement dust; cement dust may be blown away in pulverizing; brushing pan free of cement (some adheres to brush), screening cement (some adheres to sieve); screen sand and weigh as sand residue on sieve; return residue on sieve to cement and weigh as cement. The assumption is made that a sack of cement weighs 94 lb. Experience reveals that the usual variation is from 92-95 lb. Further, it is stated that the sand weighed 90 lb. per cu.ft. damp, loose, and contained by a test 2.2 per cent moisture on the day of the analysis. Actually, each load of sand varies in moisture content, the usual range being from 2 to 5 per cent. It is not stated how "loose" the sand was weighed. As to the gravel, "its moisture content was *assumed* at 1 per cent."

From this assortment of assumptions, non-representative sampling, absurdly delicate weighing and elaborate testing, data are taken whose precision cannot be of an order more than 1 part in 10 to 20 whereas results are obtained to four significant figures! The entire method is merely an estimate of later strength based on the theoretical values given by Abrams. These values cannot, of course, take any account of individual qualities of cement, water and aggregates, which often exercise significant influence in causing an actual mix to depart from the theoretical.

Misleading as the method is in its apparent results, the most serious criticism of it is that it is totally unnecessary. In place of the multiplicity of steps outlined by the method and the considerable labor involved to establish the proportions of the elements of a field mix by a small sample, these proportions can be simply established by weighing aggregates and cement in a hopper and by measuring the water when it is placed in the mixer. The proportions of every batch in the entire mass of concrete are then known, and better and more accurate predictions of strength can be made without any such analysis.

ZARA WITKIN,
Chief Engineer,
Herbert M. Baruch Corporation.

Los Angeles, Calif.,
January 29, 1930.

Floodway Work Breaks Missouri Bank

Sir—Our last bank has just crashed. The event is the natural result of the policy of establishing floodways for the Mississippi River flood control and then waiting 2½ years before giving any consideration to the question of paying for flowage rights. Back of this action of the government officials there evidently lies a fallacious idea that values within a reservoir site are not affected either by its designation as such or by its construction, but only by the actual entrance of the water when it is filled. It almost seems as though West Point or the War College should establish a course in logical thinking. Even elementary reflection on logical lines should have prevented the army engineers from proceeding with the flood-control project in the way they did, and should have enabled them to foresee the devastating effect which wrong methods might produce.

MISSOURI ENGINEER.

Charleston, Mo.,
Jan. 6, 1930.

Silt Versus Fallow

Sir—Refer to the letter of Arthur M. Shaw in *Engineering News-Record* of Jan. 16, 1930, in which he points doubt and insufficient evidence to the conclusions drawn by E. McKenzie Taylor in his article entitled "Agricultural Value of Nile Silt Held Fallacious," published in the issue of June 20, 1929.

He describes two distinct examples: One in Tabasco, Mexico, and another in the Mississippi River, but failed to point one more that he might have encountered in China on the great alluvial plains formed by the mighty rivers of that large country, where teeming millions find life by means of agriculture. These cases could not resist analysis and would be placed in the peculiar class, as would many others. They do not belong here at all.

Mr. Shaw simply failed to take into account that Prof. Taylor found himself limited during his investigation to "Silt versus Fallow." That the solution of the problem had to be one or the other. He did not overlook anything and certainly made out his point very clear: Maintenance of soil fertility is due to the annual land fallow for several months, but not to the annual silt deposition, a long established belief without experimental proof. It was not necessary, and would have been absolutely out of place, to have brought about the several other factors that help also maintain soil fertility, as rotation of crops, legumes, commercial fertilizers, favorable chemical action, physical improvement of soil, etc.

Nevertheless, it should be a very good idea to make further investigations in other places to confirm and make more evident the conclusions of Prof. Taylor.

Torreón, Coahuila, México, J. DE LA FUENTE.
January 27, 1930.

Bull Run Concrete Not Too Dry or Two Wet

Sir—The Bull Run dam of the Portland (Ore.) water system was described in your issue of Aug. 8, 1929. In the Oct. 17, 1929, number of your paper, p. 628, there occurs a letter from Hugh L. Cooper and in the succeeding Oct. 24 number, p. 665, there is an article by W. G. Chace, both commenting on methods of construction followed at the Bull Run dam.

It is rather curious that Mr. Cooper inferred from the use of chutes in placing that the concrete was too wet, while Mr. Chace argues on the basis of concrete deposition in layers with slowly rising surface toward the downstream of the dam that the concrete was too dry. The answer is as shown on p. 207 of the Torpen article that the water-cement ratio was slightly below 1 and the slump from 3 to 4 in.

It was up to the contractor to place the concrete as proportioned by the engineers. The transportation by 20-in. chute to the point of dumping was in every way satisfactory. The slopes were such that no separation occurred, and clogging in the chutes was very rare. It is true, however, that a serious drawback of the chuting plant, as installed, was the lack of flexibility, making it difficult to move the discharge end of the chute as needed. Instead of dropping concrete directly in place, the practice was to build up cones of concrete from which the material was permitted to flow sideways. Cone building favors separation, as it permits the larger aggregate to run to the bottom, where it is covered up by subsequent flow. The evil effect of this tendency has been observed elsewhere even with aggregate no larger than 3 in. In this case we counteracted this tendency by shoveling and tamping with rubber boots.

At one time a specially serious segregation had taken place and had become covered up. The place was marked, the work was stopped and after twelve hours the concrete was dug out with the rather surprising result that no voids were found and that the line of demarcation between old and new concrete could not be seen by the eye and could be told only by the difference in hardness.

It is probable that the quality of concrete suffered to some extent and in later specifications the writer prohibited placing concrete by sidewise flow. The dam has now been subject to spillway height pressure since the middle of last May. The drainage flow, which comes partly from foundation rock and largely through one contraction joint where the copper stop was damaged, amounted to 143 gal. per minute upon first filling of the reservoir and has since diminished to 94 gal. per minute. A small fraction of this, if any, comes through horizontal construction joints. Only in one spot on the downstream slope of the dam has there been any percolation that was apparent, and this was only sufficient to produce discoloration by moistening in cold weather.

At the Diablo dam, now under construction for the city of Seattle, chuting of concrete is practiced to a certain point where material is dumped on suspended horizontal conveyors which are hung so as to be easily moved, with the result that concrete is dropped vertically into place and an excellent job is obtained.

Wholesale condemnation of the chuting method of placing concrete seems to the writer unjustified, but there is excellent reason for making it plain in the specifications that concrete must be dropped into place vertically except where sloping forms make this impossible, and further that the water-cement ratio is fixed by the engineer and cannot be deviated from for the convenience of the contractor. There is no question that apparatus can be built permitting the contractor to comply strictly with these specifications.

Mr. Chace in his conclusion as to excessive dryness of concrete was undoubtedly misled by the diagram on p. 208. The actual curving up of the layers of the concrete was limited by the inclination which could be obtained by deposition in a downstream direction Thus the rise of the downstream edge, instead of being 15 ft., as he estimates from the diagram, was in fact more nearly 8 ft. While complete normality to the back slope was not attained, the usual horizontal flatness of the construction joint along which sliding might take place was avoided and the surface of the joint was made to deviate to the greatest practicable extent from the direction of maximum shear. Had such course been followed in the case quoted by Mr. Chace and shown in his Fig. 1, p. 665, it is probable that no sliding would have taken place.

Mr. Chace objects to the use of grout on the surface of old concrete ahead of the placing of new concrete. This objection might be valid if the grout were permitted to harden before being covered, but this was never the case at the Bull Run dam. Its function was to make the concrete in the immediate vicinity of the construction joint slightly richer than the remainder, so as to secure more certain adhesion, and there has been no evidence that this result was not secured.

D. C. HENNY,
Portland, Ore., Consulting Hydraulic Engineer.
Jan. 16, 1930.

Highway Tunnel Safety

Sir—Vehicular tunnels now in use are proving satisfactory from the traffic standpoint, particularly where there are two separate tunnels with two lanes of one-way traffic in each. Efficient traffic control and a reasonable minimum distance between vehicles enables good speed to be maintained, and the problem of ventilation has been solved. The travel in the Holland tunnel so exceeds anticipations that the revenue from toll, will amortize the construction bonds in half the estimated time, and the city of New York is going ahead with plans for additional tunnels to be financed on toll earnings, while elsewhere like tunnels are being constructed or projected.

This would seem the time to discuss tunnel safety. Emergency fire apparatus so far has succeeded in extinguishing the vehicle fires that have occurred, but occasional automobile fires on roads and bridges involving more than one car suggest the prudence of seeking something more than fire extinguishers to provide for safety in vehicular tunnels.

The risk of fires in buildings is not proportionately greater than among automobiles on bridges or in tunnels. As a matter of fact records show that fires of the latter kind occur almost daily. Those on bridges, where emergency apparatus is not usually provided, sometimes burn up the vehicle or vehicles involved, the others giving them a wide berth. A serious fire in a tunnel, beyond control of emergency apparatus, is a contingency which should be faced, for the results of such a fire where safety is solely dependent on their prevention would be just as unfortunate as fires in factory buildings with inadequate fire-escape facilities.

In present vehicular tunnels the only means of exit is through the ends, or through a few widely separated and restricted cross-passages to an adjacent tunnel. Two tunnels connected every 25 ft. or so, with automatic fire-doors through which safety could be quickly reached in the adjoining roadway, offer one solution of the safety problem. The construction of such tunnels presents no novelty. The numerous fire-doors, a well-known form of protection in buildings, would be visible assurance that, if anything does go wrong in one tunnel, immediate access to safety in the other is easily and quickly available.

Exhaustive study has been given to safety in railroads, bridges, buildings and dams. Is it asking too much that vehicular tunnels be given similar study and research?

JOHN F. O'ROURKE,
Consulting Engineer.

New York City,
Jan. 29, 1930.

News of the Week

Bridge Favored Over Tunnel at Seattle

The city council of Seattle, Wash., meeting jointly with the county commissioners, recently denied an application from the Traffic Tube Construction Co. for a franchise to build a vehicular tunnel under Lake Washington from Seward Park to Mercer Island. A majority of the city council is declared to be in favor of a measure providing for a bridge across Lake Washington with the mainland approach at Seward Park,

Engineering Council Organizes for 1930

Administrative officers to carry out plans for national activity in public affairs during 1930 have been announced by the American Engineering Council. Gardner S. Williams, of Ann Arbor, Mich., has been named acting president of the Council. He will occupy the office until the return from a trip around the world of Carl E. Grunsky, of San Francisco, former head of the American Society of Civil Engineers, who has been elected president for a two-year term, succeeding Arthur W. Berresford, of New York. Mr. Williams is a former professor in the University of Michigan, a vice-president of the Council, and chairman of its committees on government reorganization and on flood control. He is the representative on the council of the Detroit Engineering Society.

New members of the Administrative Board, the governing body of the Council, which represent the civil engineering field are: American Society of Civil Engineers—H. S. Crocker, Denver, Colo.; A. J. Dyer, Nashville, Tenn.; Anson Marston, Iowa State College; Frank M. Williams, Albany, N. Y. American Institute of Consulting Engineers—Edwin F. Wendt, Washington.

Cannot Enjoin Boeuf Floodway Construction

Secretary Hurley Claims Government Not Liable for Flood Damage and That Levee Work Can Go On

IN ORAL statement made Feb. 6, Secretary of War P. J. Hurley denies that the long disputed Boeuf floodway construction, which was an essential part of the plan for Mississippi flood protection adopted by Congress, can legally be enjoined. The statement in full is as follows:

"Application for an injunction to prevent construction of the protection levees in the Boeuf Basin was heard by a Federal judge in Monroe, La. Sometime after the hearing the court gave an opinion but issued no restraining order at that time.

"In so far as is known at this time no injunction has been issued. Without an injunction there is nothing for the Government to appeal, since the application for the complaint is for an injunction.

"Prior to the hearing of this case on its merits the Government filed a demurrer on the ground that the matter was not subject to injunction. This demurrer was overruled and the case ordered tried on its merits.

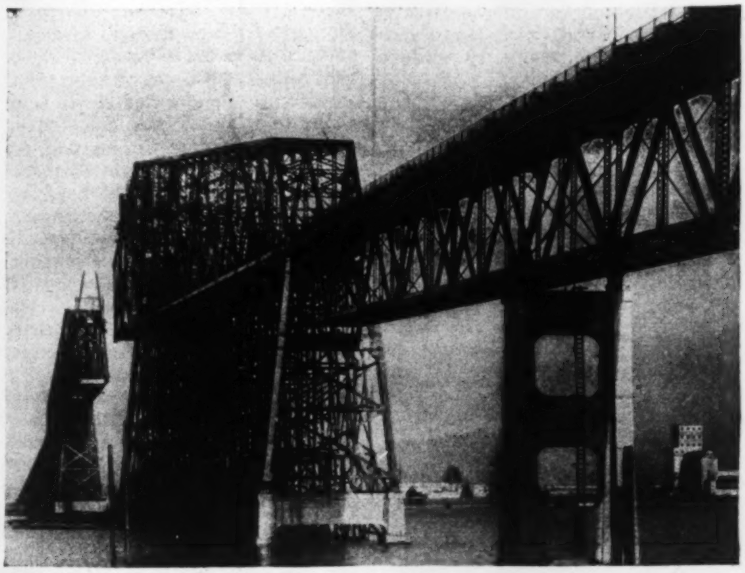
"The position of the Government is, first, that the proposed work is not legally subject to injunction and, second, that no liability of any kind shall attach to or rest upon the United States for any damage from or by floods or floodwaters at any place.

"An opinion on a principle similar to that in the Boeuf Basin, rendered recently by a Federal judge in Missouri with reference to the New Madrid floodway, as well as opinions rendered in the past by the Supreme Court, support the position of the Government. In the decisions rendered by the Supreme Court, the opinions of inferior courts situated in the localities affected were, I believe, reversed.

"This question involves payment by the United States for flowage over some 4,000,000 acres of land, mostly swamp and timber lands which have always been subject to periodic overflows. The flood control project did not contemplate such payments and there are no funds in the authorization for such payments. Hundreds of millions of dollars are involved.

"Just recently an application for an injunction against constructing protection levees in the Atchafalaya Basin was dismissed by the Federal Court in New Orleans on application of the attorneys for the complainant. This application involved principles similar to the Boeuf Basin case. The Government was relieved from opposing the injunction by reason of the application for dismissal by the complainant."

BUILDING LONGVIEW BRIDGE OVER THE COLUMBIA RIVER



This striking view, taken Jan. 9, shows falsework still in place under the 760-ft. anchor arms of the highway toll bridge connecting Ranier, Ore., and Longview, Wash. The center span of 1,200 ft. will have a clearance of 192½ ft. The construction schedule called for completion Jan. 1, but work has been delayed by extremely bad weather conditions.

Railway Planned as Part of Beauharnois Project

Permission to construct a railway line as part of the Beauharnois hydro-electric project on the St. Lawrence River has been requested of the Quebec Legislature by the Beauharnois Light, Heat & Power Co. The railroad, which would parallel the 15-mile canal between Lake St. Francis and Lake St. Louis, would aid in the construction, maintenance and operation of the canal and of industrial plants which are expected to locate along its borders.

Brooklyn-Manhattan Vehicular Tunnel Proposed

Plans for a six-lane vehicular tunnel to connect the lower end of Manhattan Island with the Borough of Brooklyn, New York City, have been prepared by Edward A. Byrne, chief engineer of the New York City department of plant and structures. The proposal includes two separate tubes, each 23 ft. 10 in. wide, containing three traffic lanes apiece, which would leave New York at the lower end of West St., pass under Governors Island, and terminate in the industrial section of South Brooklyn. The tunnel would have a length of 4.6 miles as compared with the 3½ miles of the Holland tunnel, and would cost, according to the preliminary estimate, $58,300,000 exclusive of real estate and incidental improvements in Brooklyn. This amount would be reduced to approximately $50,000,000 should two lanes be used in place of three. Access to Governors Island from the tunnel would be provided by means of vehicle elevators.

Moffat Bond Suit Remanded to Lower Court

The suit to determine the validity of $8,750,000 worth of Moffat Tunnel bonds, an amount in excess of the $6,720,000 originally authorized to finance the tunnel has been remanded by the Colorado supreme court to the district court for rehearing. The high court refused to rule on the main issue, the validity of the supplemental bonds, and demanded that one or more holders of the securities be made co-defendants with the Moffat Tunnel Commission in the litigation. Conformance with this edict, and retrial in the lower court, will again bring the matter to the supreme court for adjudication. More than $200,000, interest due bondholders on the securities under scrutiny, has been impounded by the supreme court order pending outcome of the litigation.

The Business Outlook

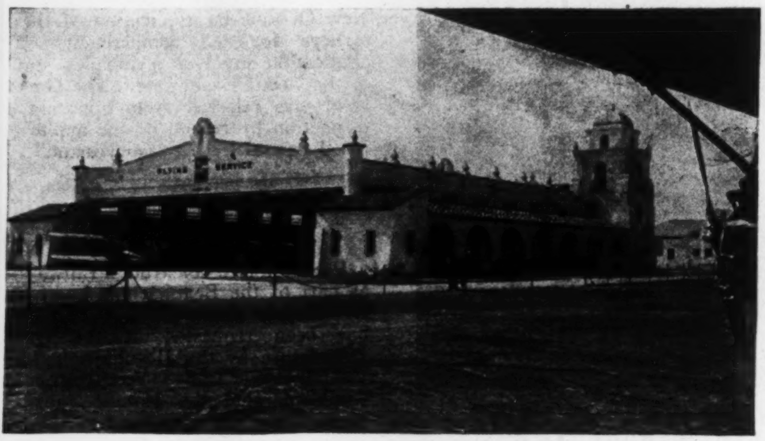
Most of the week's indicators are disappointing, and those that are not are a bit puzzling by contrast. Steel production continues to gain so rapidly that the lost ground since the stock market crash has about been recovered and there is some curiosity as to whether there will be very much more left to recover this month unless general trade conditions improve faster than they do. It seems unlikely that steel, and the automobile activity back of it, should have made a forced or false start, but if they have, general business recovery will be delayed. Total carloadings were smallest for the period in any year since 1922, but they rose slightly for the week, due principally to increased movement of coal. Bank debits in 131 cities outside stock trading centers are more than 10 per cent below last year and also below 1928.

—*The Business Week*, Feb. 8.

Labor Dispute Threatens Tacoma Power Project

Construction work on the second unit of the city of Tacoma's Cushman power project may be stopped as a result of papers having been filed in an injunction suit to restrain city officials from making further payments to the three contractors engaged in constructing the new power unit. It is alleged that provisions in the contracts providing for employment of Tacoma labor and certain wage scales have been violated, and the Labor Council is bringing suit to enforce these provisions.

NEW AIRPLANE HANGAR AT LOS ANGELES



Spanish architecture assumed a modern aspect in the design of this hangar recently completed by the Curtiss-Wright Flying Service at the Los Angeles Municipal Airport. The structure cost $75,000.

Award Contract for Rock Island Hydro-Electric Development

Following the issuance of a federal license to the Washington Electric Co., a subsidiary of the Puget Sound Power & Light Co., for the development of hydro-electric power at Rock Island on the Columbia River, a contract involving $15,000,000 has been awarded by the Engineers Public Service Corporation to Stone & Webster Engineering Corporation for the construction of the first unit of a dam and power plant at that site. Work will be started immediately on the construction of cofferdams. It is estimated that an initial generating capacity of approximately 80,000 hp. will be in service in approximately three years, with a total maximum development of 240,000 hp. planned. The dam across the Columbia River will be about 60 ft. high and approximately half a mile in length. W. D. Shannon, who was in charge of construction of both the Baker River and Shuffleton plants for the company, will be engineer in charge of this new project.

Michigan Engineers Conference on Art of Living

Record attendance, 841 registrations, marked the fourth Michigan Engineering Conference, sponsored by technical organizations, educational institutions, civic groups and individual engineers throughout the state. Its two-day meeting Jan. 30 and 31 at Ann Arbor was centered on a single theme, the engineer's contribution to the art of living. Though strictly non-technical, the meeting held close interest to the end, due in no small part to the outstanding reputation of the speakers.

C. E. Groesbeck, president of the Electric Bond and Share Co., spoke on the part of the engineer in finance. He summed up in the following: "The engineer must set his seal of approval upon an enterprise before capital will be made available." Col. W. A. Starrett, president of the Starrett Corporation, traced the historical development of the engineer as a builder from the lintel, radial arch, flat arch, the truss, window glass and the chimney, all existing without much change for ages, to the rapid development following the advent of iron. Since then structural steel, electricity, steam heat, the elevator, the telephone and adequate use of cement have revolutionized construction.

Of wide interest was a comprehensive address by L. W. Wallace, executive secretary of the American Engineering Council, on the part of the engineer in public or official life. Few realize that all departments of the Federal Government except that of Justice have engineering staffs. E. P. Goodrich, consulting engineer, New York City, spoke on "The Engineer in Modern China," where deep foundations are taboo because of the danger of uncovering malignant spirits, where a modern water system might cause 300,000 water boys to commit suicide, where natives attempt close shaves from passing automobiles to cut off following devils, where "tradition is the enemy of progress" but where the speed of action, once the modern Chinese executive is convinced, far exceeds our own. Frank C. Emerson, governor of Wyoming and formerly state engineer, presented a scholarly paper on "The Field of the Engineer in Government." In it he named the attributes of integrity, straight thinking, industry, adaptability, common sense, courage, ability to self-appraisement, tolerance, sense of humor and personality as essentially common to both successful engineers and competent public officials.

The conference was also in honor of the fiftieth anniversary of the Michigan Engineering Society which, at its business session, elected the following officers: president, F. N. Menefee, professor of engineering mechanics, University of Michigan; vice-president, D. A. Nicol; secretary, C. M. Ziegler; treasurer, Albert Roth.

Baltimore to Build Large Covered Steel Tank

Bids for a 4,000,000 gal. covered steel tank, inclosed with masonry, will soon be received by the city of Baltimore, Md. The tank, which will be located at Curtis Bay, will be 110 ft. in diameter and 60 ft. high. There will be a 2-ft. space between the tank and the masonry inclosure. The estimated cost of the work, including a water main connection and a small automatic pumping station is $200,000. The work will be done under the direction of Charles F. Goob, chief engineer of the department of public works, and Edward G. Rost, water engineer.

Columbia University to Build Large Testing Laboratory

Plans for a materials testing laboratory to contain the largest universal testing machine in the world have been announced by Dean George B. Pegram, of the engineering school of Columbia University. The new machine will have a capacity of 3,000,000 lb., will be capable of testing specimens having a length of 35 ft. and will have a width under the loading head of over 6 ft. It will be exceeded in capacity only by the compression machine of the U. S. Bureau of Standards at Washington, D. C. The new building planned to house this machine will also provide space for the present equipment of the testing laboratories of the department of civil engineering. Provision will be made for the testing of cement, concrete and highway and fireproof materials, as well as space for extensive load tests on large floor and beam construction. The foundations and steelwork of the laboratory will be so designed as to make possible an ultimate building height of fourteen stories.

Uses of Treated Wood In Many Applications Discussed at Meeting

Termites, Bridges and Buildings, Cars and Tie Treatment Among Subjects at Wood Preservers' Meeting

A WIDE range of subjects relating to wood preservatives, treating processes and the uses of treated timber was presented at the recent annual meeting of the American Wood Preservers Association, at Seattle, Wash. The growing trouble from termites, or wood-eating ants, was dealt with in three papers. Two papers by members of the California committee on termite investigations reviewed the conditions which led to the rapid spread of infestation in that state, and showed the desirability of more extensive retail supply of treated wood for ordinary building construction and farm use. The third paper outlined a series of international tests on the efficacy of various wood preservatives in resisting termite attacks; these tests have been organized by the U. S. Department of Agriculture. Specific classification and measurement of checks was recommended by a committee on non-pressure treatment for poles, as the terms "large," "small," "wide" and "narrow" are too indefinite. It recommended a revision of present specifications for immersion treatment, but thought it inadvisable to prepare specifications for surface treatment by brush and spray, as this gives only a moderate degree of protection.

Railway Structures

Creosoted preframed timber construction for a Howe-truss five-span highway bridge over the Fraser River at Quesnel, B. C., was described by P. E. Phillip, deputy minister and engineer of the Department of Public Works, British Columbia. Creosoted fir piling and preframed creosoted timbers for dock and bridge construction are used extensively on the western part of the Chicago, Milwaukee, St. Paul & Pacific Railway, as described in a paper by R. J. Middleton, assistant chief engineer. He referred to long-life records of piles, but called attention to fire hazards of docks, as instanced by fires at Seattle.

Treated lumber in car construction is not given serious consideration by railways or private car owners in general, according to a committee report, although several roads are experimenting. A sales campaign by commercial wood-treating concerns was suggested as likely to bring good results. As to the effect of blue stain in wood, studies reviewed by W. M. Saling, University of Idaho, indicate that this condition does not retard penetration or absorption, as is generally assumed, but rather increases them. The effect attributed to the "stain" is more likely due to moisture. Experiments to determine the effect of partial seasoning on the strength of timber, as reviewed by representatives of the U. S. Forest Products Laboratory, indicate that partly seasoned timber may be stronger or weaker than the green timber, largely depending upon the species.

A campaign for the more general use of zinc-chloride treatment for timber for building construction was advocated by L. C. Drefahl, of the Graselli Chemical Co., while a paper by engineers of the U. S. Forest Products Laboratory indicated that both zinc-chloride and diammonium phosphate reduce the inflammability of wood. Treatment of ties of Engelman spruce, which is highly resistant, will be satisfactory by suitable methods, especially if the surface is incised, according to J. D. McLean, also of the U. S. Forest Products Laboratory. Zinc chloride penetrates more closely than oils, and may be followed by an oil treatment to protect against checking of the wood and leaching of the salts by moisture. Mr. McLean also discussed the steaming of green-southern pine timbers before creosoting. Occurrence of fires in creosoting retorts while the charge is being treated was a hazard noted by C. M. Tilley, of the Texas Creosoting Co.

C. C. Cook was elected president of the association and J. S. Penny and E. T. Hansen, vice-presidents. The 1931 meeting will be held in Philadelphia.

Seattle Engineering Department Reorganized

The organization of work done by Seattle's city engineering department has just been changed from the district plan, whereby district engineers each had charge of all work in their district, to the division plan, under which work is divided according to its general classification. On the new basis the city engineer, W. D. Barkhuff, will have three assistants of equal rank who will function in a general executive capacity. These men, assistant city engineers, are: O. A. Piper, assigned to the general administrative control of the city engineer's organization, who will be the executive officer in the management of the department; D. W. McMorris, who will have general charge of all court and legal work, general direction of bridges, general consulting work, and special consideration and approval of all specifications and contracts; and T. H. Carver, who has been assigned to general charge of hydro-electric and water-supply department and construction. There are five assistant engineers: J. H. Quense, who has been assigned to immediate charge of water-supply design and construction; L. R. Andrews, who will have general charge of paving work, sidewalks and concrete construction; I. W. Embury, who will be in charge of sewer and grading work; H. F. Faulkner, whose duties will cover all inspection and physical tests; and C. L. Wartelle, who will have charge of plans and specifications, and design and construction of street-lighting systems.

Viaduct Approaches to Toronto Union Station Opened

Marking the near completion of the $40,000,000 program of improvement of the city of Toronto's railway facilities, trains were run into the Union Station on the new high level Jan. 21. Although the new $7,000,000 station was opened in 1927, during the intervening two years trains have arrived and departed on temporary low-level trackage pending the completion of the viaduct scheme. Six tracks have now been thrown open on the viaduct level and before the end of the year there will be twelve tracks to take care of the 200 or more trains arriving and departing daily at the union terminal.

The viaduct is 3.7 miles long and 300 to 400 ft. wide, carrying six lines of passenger tracks 17 ft. above the city streets into the new union station. As part of the general railway and harbor development the Canadian National Railways has constructed two run-around tracks over recently made land to carry freight traffic clear of the passenger station. Branches have been ramped down to give adequate freight sidings to the manufacturing districts. The entire Canadian Pacific Ry. coach yard has been elevated to leave a right-of-way for motors and trucks to pass through a 700-ft. subway 66 ft. wide and 14 ft. high. These two developments represent an additional expenditure by the railways of $8,000,000.

Iowa Engineers Discuss River Control and Airports

Confining its general meetings to two major topics, river control and airports, the Iowa Engineering Society, at its forty-second annual meeting Feb. 5-7 at Council Bluffs, left consideration of municipal, county, highway and structural-architectural subjects to the luncheon meetings of the sections covering these particular subjects. Registrations reached 100 but at a "campfire" meeting at Omaha an audience of 450 men, mostly engineers, were gathered from the Nebraska and Iowa sections of the American Society of Civil Engineers and the Omaha Engineers Club, the latter playing host.

River topics included a discussion of proposed additional straightening of the Missouri River opposite Council Bluffs which Roy N. Towl indicates would be cheaper to maintain than the present crooked stream; the question of riparian rights by a lawyer; erosion in dredged channels by Prof. W. J. Schlick, Iowa State College; a valuable hydraulic contribution on characteristics of the flow of water around bends and over embankments by D. L. Yarnell, senior drainage engineer, U. S. Department of Agriculture, and a brief account of the economics of the Mississippi flood control problem by W. W. DeBerard, associate editor, *Engineering News-Record.* Movie films of revetment, wing dams and permeable dikes as built by Woods Bros. Corporation were shown.

The airport problem was attacked in four papers, one on commercial developments by a lawyer and three in engineering papers as follows: "Planning" by B. Russell Shaw, Consultant, St. Louis; "Site and Surface Design" by C. N. Connor, American Road Builders Association, and a valuable compilation with interpretation on "Airport Drainage" by Harry E. Cotton, municipal engineer, Armco Culvert Manufacturing Association.

In his presidential address Prof. A. H. Fuller, Iowa State College, described the opportunities and obligations of the engineer in Iowa. He made a plea for a county engineer and assistant in each of 99 counties. A resolution directed to the state legislature recommended changes in the dates of the fiscal year and of municipal elections, and decried the practice of electing new council members each year.

Newly elected officers are as follows: president, A. F. Fischer, Mason City; vice-presidents, C. Moriarty, Des Moines, and Frank E. Young, Cedar Rapids; secretary-treasurer, Prof. John S. Dodds, Iowa State College, Ames. The next meeting will be held at Des Moines.

Government Officials Discuss Stream-Gaging Problems

Meeting to discuss the recent progress of stream-gaging technique, the biennial conference of the water resources branch, U. S. Geological Survey, was held Jan. 20-25 in Washington. Some 50 engineers were in attendance. All 30 of the districts covering the United States and Hawaii were represented by delegates from the field offices. Representatives from other government bureaus and from the Canadian service also took part in the sessions. It was brought out that the publication of streamflow data, which has fallen behind due to insufficient funds and personnel, is now being pushed so that the results of investigations will sooner be made available.

Several new pieces of equipment were exhibited. Among these was the Au-Lee reel and boom for use in making stream-gaging measurements. The frame of this devise is collapsible so that the whole device may be carried in a small trunk. Soundings are registered directly on a dial. Meter weights up to 50 lb. can be used. One of the advantages of the reel is that it permits suspension of the meter by a single fine wire with the return circuit for the electrical contact passing through the water. This decreases greatly the resistance of the cable to high velocities, reducing errors from this cause.

The meter problem was extensively discussed, the general opinion being that the Price meter now in use satisfies present requirements of the service, which demand a meter applicable with reasonable accuracy to all types of service ordinarily met in the field. Evidence from several districts indicated that the accuracy of this meter is well within the usual needs. Concerning its use in streams laden with ice or pulp waste, the Canadian delegate pointed out that débris often collects in the meter cups. He stated that his government is attempting to devise a propeller type meter which will stand up under field conditions.

Other subjects before the conference were single wire suspension, streamline meter weights, telephonic head sets, and new developments in recording gages. A new type of chain gage, using a wire of the airplane strand type, and an electric contact gage for stilling wells were described. Discussions as to hydraulic theory included the use of slope stations, corrections of records for rising or falling stage, critical velocity (the point on rising stages where turbulence begins), and other complex problems of the specialized field. The relations between the water resources branch and the Federal Power Commission, work on streams crossing international boundaries and state co-operation were other topics of discussion.

Government Positions Open

Civil Service positions in the engineering field to be filled in the near future, with salaries paid, include the following: hydraulic engineer, $3,800-$4,400; associate hydraulic engineer, $3,200-$3,700; assistant hydraulic engineer, $2,600-$3,100; associate engineer, $3,200-$3,700; assistant engineer, $2,600-$3,100; engineering draftsman, $1,800-$2,800; assistant geologist, $2,600; junior geologist, $2,000; junior technologist, $2,000; junior physicist, $2,000; junior engineer and deck officer, $2,000; senior computer, $2,000; junior computer, $1,440; engineering aid, $1,800. The closing dates for applications vary, the earliest being March 4. Further information can be obtained from the U. S. Civil Service Commission, Washington, D. C., or at the post office or custom house in any city.

Large Rumanian Housing Project Under American Supervision

Announcement has been made by David M. Oltarsch, New York City, of the signing of a contract whereby he, in association with Maurice Blumenthal and the German concern Basalt Attiengesellschaft, will supervise the construction of approximately 15,000 buildings over a period of fifteen to twenty years in several cities in Rumania. Included in the construction is a new capitol in Bucharest. It is stated that work on the first section of the contract, involving $16,000,000, will be started in March, and that by the end of 1930 approximately $5,000,000 in construction will be completed.

Most of the new housing is intended to benefit government officials. The work will be financed through a special government bank to be set up by the Rumanian government, which will have the assistance of German, French and Swiss bankers. The homes will have an average cost of about $2,000.

Engineer Heads Minnesota Health Board

L. P. Wolff, consulting engineer, St. Paul, Minn., was elected president of the Minnesota State Board of Health at the annual meeting in January. The board consists of nine members, all of whom except Mr. Wolff are physicians. Mr. Wolff was first appointed at the instance of a small group of engineers who appeared before the Governor in 1915 and pointed out to him the desirability of having an engineer on the board, which at that time was composed entirely of doctors. The Governor stated that the law required that the members of the board "be men versed in sanitary science," but expressed a willingness to consider evidence as to the claim of the engineers for being placed in such a position, and the qualifications of Mr. Wolff. The Governor was induced to read selected articles from *Engineering News-Record*, the American Public Health Association and extracts from certain books and some of the writings of the late George C. Whipple. The outcome was the appointment of Mr. Wolff, who has served ever since and now becomes president.

Modified Plan for Passaic Valley Flood Control Presented

Enlargement of the Vermeule plan of 1928 for controlling floods in the Passaic River has been recommended by Allen Hazen, consulting engineer, New York City, in a report to a commission on flood control created by the New Jersey Legislature of 1929. Mr. Hazen concludes that the Vermeule plan (outlined briefly in *Engineering News-Record*, Dec. 20, 1929, p. 931) would be inadequate and advises that besides quadrupling the storage capacity of Mr. Vermuele's proposed Whippanong reservoir, designed to hold back flood flows in the Whippany and Rockaway rivers, a dam be built at Mountain View to store 7.3 billion cubic feet of the flood waters of the Ramapo, Wanaque and Pompton rivers. All five of the streams just named are tributaries of the Passaic. Enlargement of the Whippanong reservoir would raise the cost of the Vermuele project by $3,000,000 to $15,000,000, but would reduce the outlay for channel improvement. The cost of the Mountain View reservoir is put at $20,000,000 and of the entire Hazen plan at $30,000,000 or more. The commission indorses Mr. Hazen's recommendations, but advises the New Jersey Legislature to create a new commission to make studies in more detail and to provide $100,000 for the purpose. It takes cognizance of the fact that the creation of a metropolitan commission for northeastern New Jersey is under consideration, to which would be intrusted flood and mosquito control, meadow reclamation and other problems affecting a large population across the Hudson River from New York City, including Jersey City, Hoboken, Newark, Paterson and many other places.

SITE OF $6,500,000 HYDRO-ELECTRIC PLANT IN PERU

Construction is now starting on a 35,000-hp. hydro-electric power plant on the Montaro River, about 16 miles north of Oroya, Peru, which will furnish electricity for the mines and smelters of the Cerro de Pasco Copper Corporation. The plant, which is being built under the direction of Sanderson & Porter, consulting engineers, of New York City, will be completed in 1931.

Brief News

THE GREEK GOVERNMENT is calling for bids March 15 for the construction of 2,600 dwellings in the city of Athens. Details can be obtained from any Greek embassy.

A $200,000 CONCRETE AND STEEL VIADUCT eliminating two dangerous grade crossings in Laramie, Wyo., was opened Jan. 30. It is 1,200 ft. long, with concrete approaches; has a roadway 22 ft. in width and a pedestrian path 6 ft. wide.

STATE HOSPITAL ENLARGEMENTS costing $18,800,000 have been approved by Governor Roosevelt of New York. It is expected that contracts will be let immediately after the 30-day advertising period.

FIVE BRANCH LINES in Alberta, Saskatchewan and Quebec with a total length of 160 miles are contemplated by the Canadian Pacific Railway, which has asked Parliament to authorize the construction and financing of the extensions.

A HIGHWAY TOLL BRIDGE across the Schuylkill River at Norristown, Pa., formerly used as a railroad bridge, has been leased for a period of 999 years by the Federal Bridge Company of New York from the Reading Railroad Company.

MODIFICATION OF THE BULKHEAD LINE on the east side of the Hudson River between 65th and 70th St., New York City, has been approved by the Secretary of War. The change, which provides for the advancement of the bulkhead line 100 ft. channelward, was necessary as a part of the West Side elimination project of the New York Central Railroad.

PLANS FOR A NEW STATE CAPITOL at Baton Rouge, La., to cost approximately $1,250,000 will soon be drawn up, according to a statement issued by Governor Long. A building of sixteen or eighteen stories is contemplated.

CONSTRUCTION of a 35,000-kv. steam-generating plant at an estimated cost of $3,500,000 by the San Joaquin Light & Power Corp., Fresno, Calif., will start by March 1, with a schedule calling for completion by June, 1931.

A SPORTS ARENA with a seating capacity of 80,000 to be known as the Soldiers and Sailors Memorial stadium is planned in Dallas, Tex., according to an announcement made by Phil T. Prathers, chairman of the state stadium committee and member of the Texas State Fair board of directors. Completion is expected by the fall of 1930.

ELECTRIC POWER PRODUCTION for 1929 in the leading cities of Europe, in billions of kilowatt-hours, was as follows: Germany, 32; Great Britain, 17; France, 15; Sweden, 9. Of the German production 15.1 per cent was derived from hydro-electric power, 43.5 per cent from brown coal, 39.9 per cent from pit coal and the remainder from Diesel engines and gas.

CONSTRUCTION by the Norfolk & Western Railway of an 8-mile extension of its Jacob's Fork branch in McDowell County, W. Va., at a cost of $1,180,000 has been authorized by the Interstate Commerce Commission. The line will extend from Newhall up Jacob's Fork and Horsepen Creek, penetrating 20,000 acres of coal land where the Pocahontas Fuel Company is planning to open new mines.

ALL JANUARY SNOW RECORDS were broken in Grand Junction, Colo., when 20.9 in. fell during the first month of the year, exceeding the former mark by 5 in. Precipitation was much needed and averts the threat that western Colorado would suffer for lack of water for hydro-electric and irrigation purposes.

WASHINGTON NOTES

BY PAUL WOOTON
Washington Correspondent

Conference Called to Consider Jurisdictional Strikes — Two New Laboratories Discussed

ACTING to set up an agency for the arbitration of jurisdictional strikes on construction jobs, a committee sponsored by the building trades department of the American Federation of Labor and by the Association of Building Trades Employers will meet March 5 in Washington. It will be recalled that this function was performed for several years by the National Board of Jurisdictional Awards, made up of employers, technical men, and labor representatives, until it came to grief due to various dissentions, principally the withdrawal of the carpenters' union after the metal fitters won the metal lath decision. A new and improved arbitration body, according to President Hoover, who is behind the movement, would save much delay in building operations, public construction included. Lacking such an agency, many contractors find themselves constantly in hot water over disputes to determine which trade is to do a given part of a job.

The present movement was initiated at a meeting in Tampa, Florida, on Jan. 24. The committee then appointed consists of M. J. DcDonough, John J. Hynes, and P. J. Morrin for labor; and C. J. Norman, J. J. Scully, and O. W. Rosenthal for the employers. To make their work a success, the committee has urged that all interested parties send in suggestions to M. J. McDonough, president-elect of the building trades department, American Federation of Labor, A. F. of L. Building, Washington, D. C., not later than March 1.

Reconsideration of Consolidation Plans Requested

Withdrawal of eastern trunk line consolidation plans submitted prior to publication by the Interstate Commerce Commission of its official plan is suggested in letters addressed by Charles D. Mahaffie, director of the Commission's bureau of finance, to the Chesapeake & Ohio, Baltimore & Ohio, Wabash and Delaware & Hudson. Expressing the view that hearings on these applications would be useless because the plans proposed do not conform in all respects with the Commission's plan and do not present the terms and conditions on which it is proposed to acquire the lines covered, Mr. Mahaffie states that the applications should either be withdrawn by the roads or dismissed by the Commission.

Colorado Railroad Consolidation

To the Interstate Commerce Commission's railroad consolidation plan may be attributed the settlement of a long-standing dispute between the Denver & Rio Grande Western and the Denver & Salt Lake railroads concerning the use by the former of the Moffat tunnel. At various times the roads have been so widely split that the Denver & Rio Grande Western has proposed building its own tunnel and the Salt Lake has threatened to build its own line from Craig, Col., to Provo, Utah, thus opening a new short route between Denver and Salt Lake City.

Under the commission's consolidation plan both roads are allocated to the Missouri Pacific system and now the Denver & Rio Grande Western has brought forward a proposal to acquire control of the Salt Lake. In an application filed with the commission, the D.&R.G.W. states that it has purchased 21,334 shares of Salt Lake at $155 and requests authority to purchase an additional block of 7.635 shares at the same price per share from George H. Burr & Co., of New York City. The total of 28,969 shares would give the D.&R.G.W. 58 per cent control of the Salt Lake, and presumably there would be no further controversy concerning the use of either the Dotsero cutoff or the Moffat tunnel.

Highway Research Laboratory Lost

In reporting the agricultural appropriation bill to the Senate, the appropriations committee has adopted an amendment striking from the bill the House provision for the construction of a public roads research laboratory building in the vicinity of Washington. As it passed the House, the bill authorized the appropriation of $300,000 for the construction of such a laboratory.

Representatives of the Bureau of Public Roads explained to the committee that they have had an appropriation of $75,000 for several years for the construction of a laboratory to be used in connection with road engineering work. It was pointed out, however, that this appropriation is not sufficient, in the opinion of the bureau, to house the growing experimental work that is being done adjacent to the Arlington Farm. During the discussion of the matter in the committee, Senator Jones, of Washington, and other senators expressed the opinion that the type of laboratory proposed is unnecessary at the present time, and that such highway research work as may be necessary can be carried on in cooperation with the Bureau of Standards.

Dr. Burgess, Director of the Bureau of Standards, testified that his bureau is qualified to carry on tests and investigations on practically all materials relating to highway construction. He explained that the bureau has cooperated extensively in the past with Public Roads officials in experimental work with highway material. The usual practice has been for the Bureau of Standards to handle the laboratory end of such and for the Bureau of Public Roads to handle what might be termed the service end, he said.

The attitude of the Bureau of Public Roads on the matter was explained by Thomas H. MacDonald, chief of the bureau. While purely scientific research work is within the province of the Bureau of Standards, experimental work of an administrative nature is a necessary function of the Bureau of Public Roads, he said. He pointed out that the public roads officials are charged with the responsibility of checking up and determining from time to time the standard of the materials that are being used in federal aid highway projects, an administrative function that can not be delegated.

Army Engineers Favor Hydraulic Laboratory

In recent testimony before the House, Rivers and Harbors Committee on the Hydraulic Laboratory bill, Major General Lytle Brown, chief of army engineers, discounted the fears of committee members that the proposed institution would interfere with the operations of the army engineers or prove to be "an entering wedge that would diminish their prestige." This last misgiving was expressed by Representative McDuffie of Alabama. Taking issue with the objections raised by his predecessor, General Jadwin, General Brown stated that the establishment of a national hydraulic laboratory at the Bureau of Standards would fill a definite need for fundamental research along such lines.

While it is necessary for the army engineers to make occasional field studies of hydraulic problems, General Brown pointed out that the proposed institution would not interfere in any way with this work. On the contrary, the Corps of Engineers undoubtedly would find a national hydraulic laboratory useful to them in establishing basic data.

Chairman Dempsey of the Committee stated that while he favors the enactment of legislation authorizing the establishment of a hydraulic laboratory at the Bureau of Standards, he does not believe that the present bill can pass the House. The crowded state of the calendar precludes the passage of all except the most important legislation, he said. He therefore proposed that the necessary authorization be attached as an amendment to the pending rivers and harbors bill. Other members of the committee indicated that Mr. Dempsey's suggestion would be the best course to pursue.

Personal Notes

THOMAS F. FARRELL, New York state commissioner of canals and waterways, has been made chief engineer of the state department of public works. He succeeds William M. Acheson, who died Jan. 25.

WARREN R. NEEL, state highway engineer of Georgia since 1917, has resigned and B. P. MCWHORTER has been elected acting engineer.

Dr. MATHIAS NICOLL, JR., has resigned as New York state commissioner of health to accept the position of health officer of the newly created Westchester County (N. Y.) health district.

D. W. HOLTON has been appointed superintendent of the District of Columbia water department, succeeding J. S. Garland, who resigned Nov. 1. Mr. Holton has been with the municipal service since 1898.

GUY L. BAYLEY and HARRISON SMITH have been admitted as partners in the engineering firm of Sanderson & Porter, New York City.

WALTER E. ROBERTS has been appointed county engineer of Hunterdon County, N. J., succeeding Grant Davis, who has retired after twenty years of service with the county.

JAMES H. DINGLE has been unanimously re-elected city engineer of Charleston, S. C., by the city council. Mr. Dingle has served in that capacity for 36 years.

ED BREWSTER, formerly with the Briggs Construction Co., has accepted a position with the Western Metal Mfg. Co. and will be located in Mexico City.

LOUIS C. BRANDT, building contractor, of Indianapolis, has been made a member of the Indianapolis board of public works by the new mayor.

HENRY MAAG, contract engineer for the H. K. Ferguson Co., Cleveland engineer and builder, has been appointed manager of the new branch office recently opened by the company in Chicago.

ROSS E. WINDOM has been elected city manager of Westerville, Ohio, succeeding L. G. Whitney, who has accepted a similar position at Piqua. Mr. Windom has been for the last five years electrical engineer and director of public service at Westerville.

ROBERT E. KINKEAD, arc welding specialist and consulting engineer, has opened an office in Chicago in addition to his present Cleveland office.

J. C. NEWMAN, who was transferred from Norfolk to Richmond on Jan. 1 as engineer of maintenance-of-way for the Virginia Electric & Power Co., has been in charge of track maintenance on the Norfolk properties for several years. Before going to Virginia he was engaged for three years by the Public Service Commission of New York, being in charge of track alignment and grades on the construction of rapid-transit lines in New York City.

JAMES H. KENNON, head of the distribution division of the Pittsburgh, Pa., bureau of water, has been appointed managing engineer to succeed the late E. E. Lanpher. Mr. Kennon has been connected with the city water bureau for 21 years.

ALBERT S. HIBBS, since 1922 assistant superintendent of the bureau of water supply at Akron, Ohio, has resigned to take a similar position at Cincinnati. WENDELL R. LA DUE, designing engineer for the Akron Department since 1923, has been promoted to the vacancy.

ROBERT SPURR WESTON, of Boston, Mass., has accepted membership on the sub-committee on plumbing of the U. S. Department of Commerce Building Code Committee. Mr. Weston is president of the New England Water Works Association and a member of the executive boards of the American Institute of Consulting Engineers and the sanitary engineering division of the American Society of Civil Engineers.

G. G. MCCAUSTLAND, formerly assistant city engineer of Richmond, Ind., is now engineer for the city plan commission of Kansas City, Mo.

HARRY A. WARD, for eleven years resident engineer for Turner Construction Company at Buffalo, has been elected vice-president in charge of the Buffalo office to succeed the late William E. Lyle.

HERBERT W. PIERCE, of Rochester, N. Y., former commissioner of public works, has been appointed secretary to the Monroe County Park Commission to succeed Mead B. Rappleye, resigned. Mr. Pierce has also served as superintendent of the Rochester City Planning Commission.

STANLEY NEWMAN, for eight years manager of the waterproofing division of the E. Stanley Wires Co., announces the organization of his own company under the name of the Stanley Newman Co. Offices will be in Boston and the company will specialize in eliminating damage caused by water to masonry and concrete structures.

JOHN F. PIERCE, formerly city manager of Springdale, Pa., has joined the American & Foreign Power & Light Co. as water-works engineer. Mr. Pierce will make a study of the water plants in Cuba owned by this company. Previously to being city manager Mr. Pierce was with Metcalf & Eddy, consulting engineers, of Boston, Mass.

Society Calendar

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; annual meeting, Chicago, Ill., March 11-13.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; spring meeting, Sacramento, Calif., April 23-24.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, St. Louis, Mo., June 2-6.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES, Trenton; annual convention, Syracuse, N. Y., Feb. 19-21.

ENGINEERING INSTITUTE OF CANADA, Montreal; annual convention, Ottawa, Ont., Feb. 12-14.

CEMENT GUN CONTRACTORS ASSOCIATION will hold its annual convention Feb. 17-19 at Chicago, Ill.

ENGINEERING SOCIETY OF WISCONSIN will hold its 22nd annual convention At Madison, Feb. 20-21, with a special session for surveyors on Feb. 19. R. S. Owen, Madison, is secretary.

GENERAL CONTRACTORS ASSOCIATION OF MILWAUKEE at a recent meeting elected H. L. Foster president, Arthur K. Bently vice-president, F. R. Bell secretary, and D. J. Baker treasurer.

HIGHWAY ENGINEERS ASSOCIATION OF MISSOURI will meet Feb. 18-20 at Kansas City, Mo.

MATERIALS HANDLING will be the subject of a special meeting of the American Society of Mechanical Engineers to be held March 5-7 at Chicago in conjunction with the National Industrial Exposition of material-handling equipment.

NATIONAL DRAINAGE CONGRESS will hold its nineteenth annual session at St. Louis, Mo., Feb. 19-21.

PENNSYLVANIA ASSOCIATION OF PLANNING COMMISSIONS will hold its annual conference at Easton, Feb. 18-19.

TEXAS WATERWORKS SHORT SCHOOL met Jan. 27-30 at Abilene with more than 200 delegates present. Both laboratory work and lecture courses were given. Topics discussed included: insurance rates; legislative protection for water supplies; underground surveys; cross-connection control; water main sanitation; algæ, odor and taste control; home made alum; treatment of highly-polluted supplies; watershed control; aftergrowths; and the painting of standpipes. In addition, there were a dozen papers on sewage treatment. The next school will be held at Waco. Newly-elected officers of the Texas section, Southwest Water Works Association are: president, L. A. Grimes, superintendent of water supply, Abilene; vice-president, W. H. Deaton, Bud A. Randolph, J. R. John and George Miney.

Obituary

C. L. CANON, resident engineer on a waterworks projects at Dayton, Tex., was accidently drowned while inspecting a bridge over the Trinity River near Dayton and Liberty, Tex.

CHARLES E. EATON, designer of paper mills, dams and hydro-electric developments, died Feb. 4, at Clayton, N. Y. He was 71 years old. Until his retirement two years ago Mr. Eaton had maintained offices at Watertown.

WILLIAM M. WILLIAMSON, senior engineer in the office of Chief of Engineers, U. S. War Department, died Feb. 6, at the age of 56. Mr. Williamson had been connected with the Corps of Engineers for more than 30 years.

WILLIAM E. LYLE, vice-president of the Turner Construction Company in charge of the Buffalo office, died in Buffalo Jan. 25. Mr. Lyle, who was 46 years old, had been with the firm since 1905, and had been in the Buffalo office for the past twenty years.

Construction Equipment and Materials

Southwest Road Show and School to Be Held Feb. 25-28

The fifth annual Southwest road show and school, which includes an exposition of roadbuilding machinery, construction and building materials and supplies will be held Feb. 25-28, 1930, at Wichita, Kan. At the school, sponsored by the U. S. Bureau of Public Roads, the engineering division of Kansas State Agricultural College and a number of state highway departments, consideration will be given to highway construction, maintenance and design, with particular attention to development of low-type roads.

Welded Tubing Patents Upheld

Control of the Johnston process for electric welding of steel tubing has been secured to the new $350,000,000 midwest steel merger built around the Republic Iron & Steel Co., Youngstown, Ohio, by a decision handed down in the United States district court in Brooklyn, N. Y. The case was a patent suit brought by Steel & Tubes, Inc., Cleveland, Ohio, a subsidiary of the Republic Iron & Steel Co., and owner of the electric welding patents, against the Greenpoint Metallic Bed Co. of Brooklyn. Federal Judge C. G. Galston, of Brooklyn, held that the patents were valid and had been infringed. Republic is using the process and is building a new $10,000,000 electric welding tube plant at Youngstown. The patents involved cover the method and apparatus which permits the electric welding of the tubing at a speed of 65 to 150 ft. per minute, against an average of about 12 ft. for the older welding processes.

Cement Manufacturers Form New Trade Association

The Cement Institute, a trade association of manufacturers of portland cement formed last November, has established general offices in New York City and district offices in Chicago and Kansas City. Luther G. McConnel is general manager, with George H. Reiter and Baxter D. MacLain managers of the Chicago and Kansas City offices. Activities of the Institute will include the collection and dissemination of information with respect to trade and commerce, involving credit information, contracts for immediate and future delivery, production, stocks on hand and shipments of clinker and portland cement, and tabulation of cloth sack returns. In addition, it is the institute's purpose to draw up a lawful plan for the general development and improvement of the industry. It has already formulated a code of ethics for the guidance fo its members. Officers of the Institute are: president, Blaine S. Smith, president, Pennsylvana-Dixie Cement Corporation; vice-president and treasurer, Morris Kind, president, Hercules Cement Corporation; vice-presidents, M. C. Monday, president, Hermitage Portland Cement Company, Charles Irvin, vice-president, Alpha Portland Cement Company and J. A. Lehaney, vice-president and manager Lone Star Cement Company of Kansas.

Two Cement Producers Combine

Following the purchase of the properties of the Atlas Portland Cement Co. by the Universal Portland Cement Co., the latter has changed its name to Universal Atlas Cement Co. in order to give expression to the broadened scope of its business. It will continue to produce the products of both the former companies, namely, Atlas and Universal portland cement, Atlas white portland and Lumnite. The plants of the combined company are at Hudson, N. Y.; Northampton and Universal, Pa.; Buffington, Ind.; Duluth, Minn.; Hannibal, Mo.; Independence, Kan.; Leeds, Ala.; and Waco, Texas.

J. R. Morran, president of the Atlas company, and L. R. Burch and H. W. Maxwell, vice-presidents, have resigned. B. F. Affleck continues as president of the Universal Atlas company, and H. E. Harding is secretary and treasurer.

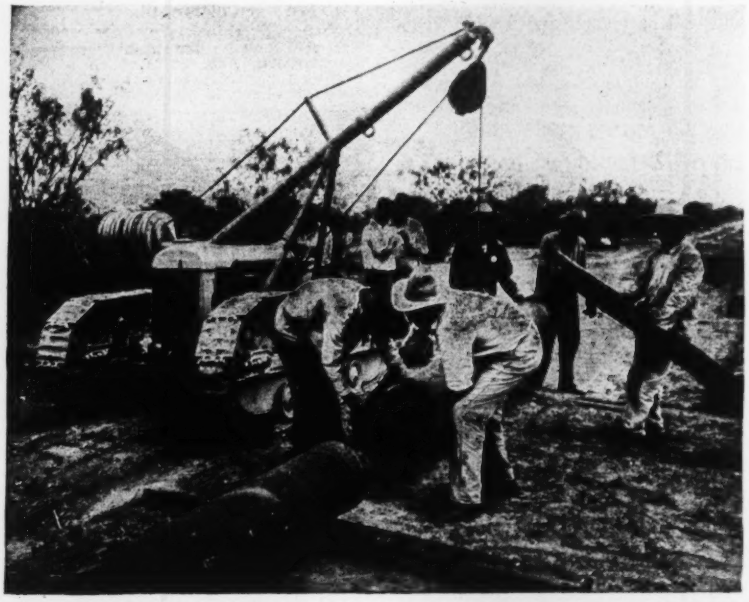
New Type Structural Steel Being Exported by Germany

German steel mills have begun to export the new "ST 42" high-tensile-strength rust-resisting structural steel. The new type has been adopted by the German Bureau of Standards as the standard steel for all construction work. It contains a little less than 0.20 per cent copper to make it rust resisting. The specifications call for a tensile strength of at least 52 kg. per square centimeter (74,000 lb. per square inch). All the newer bridges in Germany are being constructed with the new type of steel.

Sand and Gravel Meeting Favors Standardization

Steps leading toward the elimination of two outstanding problems of the sand and gravel industry were inaugurated at the convention of the National Sand and Gravel Association at Memphis, Tenn. Reduction in the number of sizes of gravel from 50 or more in every locality to six was suggested in a report of the committee on standard specifications which will be submitted to the membership of the association for approval. Should these specifications prove satisfactory, they will be submitted to the bureau of simplified prac-

ASSEMBLING MEXICO'S FIRST WELDED PIPE LINE



Natural gas from Texas is being delivered in Monterey, Mexico, by means of a 12-in. welded pipe line 165 miles long recently completed by Smith Brothers, Inc., Dallas, Texas. Current for welding this line was furnished by 90 Lincoln gasoline-driven welders moved along the line by tractors. Because of the legal requirement that the greater part of the work must be done by residents of the state in which it is situated, much of the welding was done by operators with no previous experience of this kind.

tice of the U. S. Department of Commerce, for adoption throughout the industry.

The convention adopted the suggestion of the trade relations committee that it hold a trade practice conference with the Federal Trade Commission in the near future for the purpose of establishing a code of ethics. Rules for the guidance of the industry will be prepared along the lines of those already adopted under the auspices of the Federal Trade Commission by many other industrial groups.

Concrete Pavement Yardage

There is given below a tabulation of concrete pavement yardage awarded during the month of December, 1929, and also the total number of square yards awarded for roads, streets and alleys in the United States for the year 1929.

	Sq.Yd. Awarded During December, 1929	Sq.Yd. Awarded From Jan. 1, 1929 to Dec. 31, 1929
Roads..........	5,042,780	92,552,944
Streets..........	2,312,238	43,452,159
Alleys..........	106,888	3,658,316
Totals......	7,461,906	139,663,419

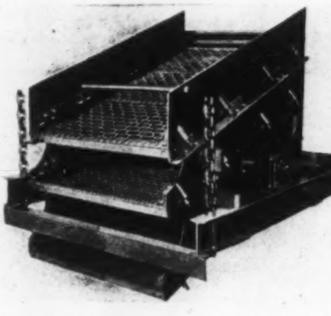
Manufacturers Invited to Show Products at Mexico City

Members of the Manufacturers' division of the American Road Builders' Association have been invited by the Mexican Government, through the National Highway Commission, to exhibit their products at the third National Highway Congress which will be held in Mexico City in April, 1930. Machinery for this purpose may be shipped into Mexico in bond without the payment of duty, and reduced freight rates are available. Further particulars may be obtained from the headquarters of the association in Washington, D. C.

New Developments

Durability Feature of New Vibrating Screen

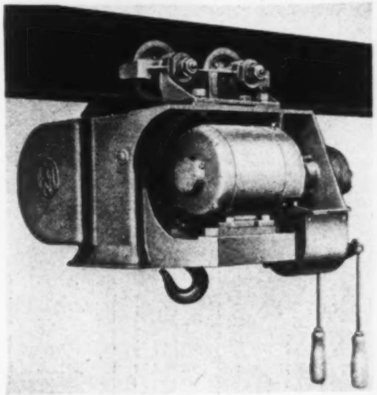
Ability to develop positive vibration, together with construction which will withstand this vibration with no detrimental effects, are combined in the new vibrator screen recently announced by the Stephens-Adamson Manufacturing Co., Aurora, Ill. The screens are built in sizes varying from 2 by 4 ft. to 5 x 8 ft., all available in single-, double- and triple-deck assemblies. Four different rotor mechanisms are built for installation in the several assemblies, selection being governed by the severity of duty. Among many new features of design are the use of self-aligning ball and roller bearings and of pressure lubrication to each individual bearing, in combination with labyrinth grease seals for excluding dirt. Flywheel weights are so arranged as to be easily adjustable. Suspension is by four forged chains to eliminate the possibility of transmitting lateral vibration to the supporting structure or building. Screens are of standard steel wire, manganese or special spring wire, according to the requirements of the service. The spring panels are held in place by easily detachable clamps. Power is provided by constant speed inclosed fan-cooled electric driving motors operating at 1,800 r.p.m. and driving through multiple V-belts.



TRIPLE-DECK VIBRATING SCREEN

New Electric Hoists Announced

A complete line of electric hoists in sizes ranging from ⅛- to 7½-ton capacity is announced by the hoist and crane division of Robbins & Myers, Inc., Springfield, Ohio. A number of outstanding features are incorporated in these new hoists, among which are: (1) a radical improvement in design with a resultant saving of both weight and space in all dimensions, headroom included; (2) a cast-steel trolley adjustable to nine sizes of I-beams; (3) a safety constructed inclosed bottom block which retains the rope on the sheaves heat treated to rigid specifications which allow for the maximum strain of constantly reversing tooth loads at top motor speed; (5) Hyatt roller bearings in the hoisting mechanism; (6) a main frame of Aremite alloy metal, produced in the Robbins & Myers foundry by electric process, which has a tensile strength of 35,000 lb. per sq.in., or more than double the strength of gray iron, with an elasticity which enables it to stand shock more readily than cast iron; (7) aluminum finish throughout.



ROPE-CONTROLLED ELECTRIC HOIST

Business Notes

Trade Practice Conference Rules adopted by the structural steel fabricating industry at a conference held Nov. 11, 1929, at Biloxi, Miss., have been acted upon by the Federal Trade Commission. Eight rules were affirmatively approved and eight others accepted as expressions of the trade. No action was taken on six definitions formulated at the conference, nor upon two resolutions providing for the creation of committees to draft standard proposal and contract forms and to investigate whether the rules are being observed throughout the industry.

Leipzig Trade Fair, which has been held without interuption twice a year for nearly seven centuries, will be held in Leipzig, Germany, March 2-12. Detailed information may be obtained from the American headquarters at 11 West 42nd Street, New York City.

Southwark Foundry and Machine Co., Philadelphia, Pa., has just complete a Southwark-Emery 3,000,000-lb. testing machine which may be inspected at the plant until Feb. 21. The machine is equipped with the Emery hydraulic weighing system, provides a maximum opening for tension and compression of 38 ft. 6 in., a clear distance between columns of 7 ft. 6 in. and a 36-in. stroke.

Curtin-Howe Corporation, New York City, has licensed the T. J. Moss Tie Company, of St. Louis, Mo., to use the ZMA process of wood preservation at its plant at Mount Vernon, Ill.

Northwest Concrete Products Association met in Seattle, Wash., Jan. 27-28. The following officers were named for the ensuing year: president, Hans Mumm, Everett; vice-presidents, Clyde Brutve, Portland, Ore., Carl Warren, Spokane, and E. L. Warner, Tacoma; secretary-treasurer, W. M. Hews. The meeting was attended by thirty-eight cement and concrete representatives from Washington, Oregon and Idaho. The mid-summer convention will be held in Bellingham during the month of July.

American Rolling Mill Co., Middletown, Ohio, has enlarged its executive staff by creating the offices of chairman of the board and vice-chairman, in addition to existing positions. George M. Verity, president of the company since its inception, is now chairman of the board, and Joseph H. Frantz, first vice-president for the past sixteen years, is vice-chairman. Charles R. Hook, formerly vice-president and general manager, will succeed Mr. Verity as president, retaining the position of general manager. He will be assisted by Calvin Verity, who is now vice-president and assistant general manager. E. N. Millan, formerly chief of construction, is now chief engineer. W. W. Lewis, technical director of the Armco International Corporation, has been appointed assistant to W. W. Se-

Costs and Contracts

E. N.-R. Index Numbers

Cost			Volume		
Feb. 1,	**1930**	**206.46**	**January,**	**1930**	**199**
Jan. 1,	1930	208.96	December,	1929	166
Feb. 1,	1929	210.40	January,	1929	325
Average,	1929	207.02	Average,	1929	317
Average,	1928	206.78	Average,	1928	287
1913........		100.00	1913............		100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of Feb. 13, with some comparisons, total as follows:

(In Thousands of Dollars)

	Feb. 13, 1930	Jan. 6, 1930	Feb. 14 1929
Buildings:			
Industrial.....	$3,755	$1,532	$11,625
Commercial....	15,003	7,900	70,646
Streets and roads.	4,460	8,458	2,161
Other eng. constr.	11,183	10,616	4,597
Total.........	$34,401	$28,506	$89,029
Total, all classes, Jan. 1 to Feb. 13:			
1930..............................			$301,843
1929..............................			602,600

bald, vice-president in charge of general activities and developments.

Clarence W. Hodges, general purchasing agent of the Worthington Pump and Machinery Corp., New York City, died Jan. 17 at Paterson, N. J., at the age of 53. Mr. Hodges was a graduate of Williams College and had been with Worthington since 1918. Before that time he had been purchasing agent for American Locomotive Co.

Francis Cole Pratt, former vice-president and chairman of the manufacturing committee of the General Electric Co., died Jan. 26 in New York City. After graduating from the Sheffield Scientific School of Yale University in 1888 he became associated with the Pratt and Whitney Company, joining the General Electric Company in 1906. He became vice-president in charge of engineering in 1919, and retired in 1927.

The Business Side of Construction

Prices Steady, with Sales Low

Because of small demand and despite resulting keen competition, prices have remained steady.

Lumber production and shipments are under those of a year ago, but stocks are 9.6 per cent higher, which means that output must be further reduced if present prices are long to continue. The situation is better in the West, where snow has stopped production and stiffened the fir market. Jobbers in the New York metropolitan district may find profits reduced by higher water freight rates on Northwest fir.

Cement production is 2.8 per cent under that of a year ago; demand is down 3.4 per cent; stocks 2.6 heavier. This does not look like higher prices. Average mill price is $1.73, compared with $1.80 a year ago.

Steel beams are now quoted at $1.80, or 10c. less than last month. A freight advance of 70c. on lime may be added to dealers' prices. Gypsum products are steady, as also are sand, gravel and stone. Brick averages $14.63, compared with $15.13 a year ago.

Unemployment in the Building Trades

The Department of Commerce report that unemployment has increased 3.3 per cent does not include the building trades. In these, in January, 38 per cent of the union membership was unemployed, the largest in three years. The condition is particularly severe in Oakland, Portland (Ore.), Minneapolis, St. Paul, Milwaukee, Chicago, St. Louis, Detroit, Jersey City, New York, Philadelphia and Washington.

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Advances since last month are indicated by **heavy type**; declines by *italics*

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor*
Atlanta	$1.25@1.40	$0.60@.70	$0.60@1.00	$0.50	....	$0.75@1.25	$0.25@.35
Baltimore	1.75	1.00@1.10	1.00@1.37½	.65	$1.00	1.00@1.25	.35
Birmingham	1.50	1.00	1.25	.50	....	1.25	.20 @.35
Boston	1.50	1.37½	1.37½	.85	1.27½	1.37½	.45 @.80
Cincinnati	1.62½	1.40	1.40	1.00	1.40	1.40	.40 @.60
Chicago	1.70	1.62½	1.62½	.97½	1.62½	1.62½	.97½
Ceveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.40@.87½
Dallas	*1.67½*	1.12½	1.25	*.35* @ .75	1.25	1.25	.35@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	....	1.25	.62½
Detroit	1.56¼	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.37½@.60
Kansas City	1.50	1.25@1.37½	1.25@1.37½	.90	1.25	1.37½	.40@.75
Los Angeles	1.25	1.00	1.00	.62½@1.12½	.81¼	1.00	.50
Minneapolis	1.25	.87½@.95	.87½	.75	....	1.00	**.45**@.60
Montreal	1.25	.80	.75	....	.90	1.00	.35
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.87½	1.65	1.92½	1.18¾	1.10@1.23¾	1.92½	1.03⅛
Philadelphia	1.75	**1.50**	1.02¼	.70@1.12½	1.00	1.37½@1.50	**.40**@.50
Pittsburgh	1.70	1.50	1.43¾@1.56¼	1.12½	....	1.50	.40@.80
St. Louis	1.75	1.50	**1.60 @1.75**	1.15@1.25	1.25	1.62½	.40@.87½
San Francisco	1.37½	1.12½	1.12½	.87½	1.12½	1.37½	.68¾
Seattle	1.50	1.12½	1.12½@1.25	1.00	1.12½	1.25	.70

*Minimum rates are for construction other than buildings, non-union.

Contracts for Year 1929 and for January 1930

SECTIONAL DISTRIBUTION OF ENGINEERING CONSTRUCTION CONTRACTS—1929

(Thousands of Dollars (000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Canada
Water-works	$2,523	$14,089	$2,035	$15,172	$8,150	$6,648	$48,617	$4,434
Sewers	3,015	23,254	8,520	32,915	13,560	6,410	87,674	5,793
Bridges, private	25	9,828	1,461	6,295	3,945	16,042	37,596	....
Bridges, public	3,685	26,034	13,281	18,668	25,943	10,381	97,992	4,990
Excavations, drainage, etc.	832	2,289	3,095	7,758	15,718	1,878	31,570	4,485
Streets and roads	23,410	151,938	64,797	95,818	143,533	59,856	539,352	18,959
Industrial buildings	44,746	194,928	80,097	99,916	75,531	52,095	547,313	41,887
Commercial buildings	111,727	926,338	42,024	347,006	118,322	124,868	1,670,285	41,543
Public buildings	39,091	131,768	15,334	76,494	23,336	19,679	305,702	14,441
Federal government	1,452	38,607	27,930	8,628	16,019	11,265	103,901	....
Unclassified, private	5,285	55,297	69,838	33,604	133,411	51,193	348,628	18,685
Unclassified, public	2,147	106,132	1,572	4,758	6,019	11,057	131,685	34,031
Total private	161,783	1,186,391	193,420	486,821	331,209	244,198	2,603,822	102,115
Total public	76,155	494,111	136,564	260,211	252,278	127,174	1,346,493	87,133
Grand total	$237,938	$1,680,502	$329,984	$747,032	$583,487	$371,372	$3,950,315	$189,248

VALUE OF CONTRACTS AWARDED IN THE UNITED STATES AND TOTAL FOR CANADA, JANUARY, 1930

Thousands of Dollars (000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	January, 1930	Canada Jan., 1930
Water-works	$515	$99	$219	$621	$1,090	$2,283	$4,827	$20
Sewers	144	1,698	338	3,006	2,824	396	8,406	423
Bridges, private	....	....	....	250	750	....	1,000	....
Bridges, public	....	3,161	859	1,317	1,866	595	7,798	70
Excavations, etc.	....	42	2,514	266	285	222	3,329	....
Streets and roads	1,085	10,981	3,130	2,412	7,503	7,041	32,152	1,120
Industrial buildings	1,122	5,097	1,617	11,495	2,586	16,805	38,722	1,200
Commercial buildings	2,550	39,543	4,590	8,507	3,013	14,853	73,056	3,125
Public buildings	1,564	12,518	1,358	4,074	1,835	1,240	22,589	5,843
Federal government	53	1,089	557	991	5,694	1,150	9,534	....
Unclassified, private	295	13,115	7,450	765	717	750	23,092	1,810
Unclassified, public	25	9,167	300	562	4,293	84	14,431	1,101
January, 1930, 5 weeks	$7,353	$96,510	$22,932	$34,266	$32,456	$45,419	$238,936	$14,712
December, 1929, 4 weeks	16,953	67,925	6,855	20,589	34,916	13,970	161,208	13,570
January, 1929, 5 weeks	27,073	156,358	20,953	52,311	100,577	39,561	396,833	11,247